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THE ORIGINAL AND ONLY AUTHORIZED EDGAR RICE BURROUGHS FANZINE

The Mucker vs. The Big Smoke

RANDOM BURROUGHING

by Allan Howard

The recent death of ex-heavyweight champion Jess Willard at age 86 served to remind a host of sports-writers (most of whom were not around at the time) of the short and improbable era of the "white hope" in fistic history. At the same time there is currently running on Broadway, at the Alvin Theatre, a play entitled, "The Great White Hope", which has achieved the status of a hit. It is a prize ring drama based, not at all loosely, on the career of Jack Johnson, who was the first black man to win the heavyweight championship of the world.

Jack Johnson reigned from December 26, 1906, when he took the title from Tommy Burns in 14 rounds at Sidney, Australia, until he was defeated by Willard in Havana on April 5, 1915. Johnson was an extremely clever boxer and ring general, possessing a good punch, and is rated one of the best to wear the heavyweight crown. He also proved in his fight with that thunderous belter, middleweight ruler, Stanley Ketchell, known as "The Michigan Assassin", that he could take it. Johnson arose from a mighty Ketchell wallop to starch Stanley with one punch.

Like the later black champion, Joe Louis, Johnson possessed all the ring attributes to have made him a popular champion. Unfortunately, and unlike Louis, his personal life made him an object of hatred to the white populace. This touched off the most incredibly frenzied hunt in ring history. Fight managers scoured the world looking for a "white hope" to take back the championship from this impudent Negro who dared to flaunt himself in the face of the respectable white populace. Any Caucasian male (American Indians were welcome too) over 175 lbs., and who looked tough, was fair game to fast-talking scouts and promoters, who promised wealth and glory. Willing or reluctant, with or without a contract they came, from the big cities, the farms, the logging camps, and the mines. Some of the most inept giants in the annals of ringdom were laced into boxing gloves for their maiden fights, which all too often immediately disclosed their utter lack of qualifications. Two of the more promising, Luther McCarty and Bull Young met death from injuries sustained in the ring. Even the comfortably retired former champion, Jim Jeffries, was coaxed, or coerced into returning to the wars for the honor of the Caucasians. Aging and fat, Jeff fell before Johnson in 15 rounds at Reno, Nevada on July 4, 1910.

An interesting sidelight and little-known fact is that the very first white hope was later Oscar-winner Victor McLaglen, who met Johnson in a 6 round no-decision bout on March 10, 1909 in Vancouver. McLaglen injured Johnson's eye, which forced the champion to postpone his next fight with Philadelphia Jack O'Brien. Most of the "newspaper decisions" went to McLaglen.

Among these white hopes being unveiled every week was, apparently, none other than Billy "Sailor" Byrne of Chicago, ex-mucker. (Incidentally, my own idea of perfect casting for an actor to portray the Mucker would have been the young McLaglen. Of course, it would have to have been a silent, so that McLaglen's British accent wouldn't have destroyed the illusion.) Upon his return from the lost Samaul islan of Yoka, Byrne, at loose ends, and unwilling to return to crime, entered upon a career in boxing. Billy was 21 at the time, figuring forward from Burroughs' testimony that he was "about 17" when he first became interested in the ring.

Burroughs never mentioned the year in which any particular event in Billy's life was taking place, but he did state that the murder of Old Man Schneider occurred

on a September 23. The chronology of Billy's adventures while a fugitive as an alleged murderer has a couple of imprecise mentions of "weeks" or "days" elapsing between events. Nevertheless a fairly careful checking of the recorded time periods and a reasonable guess at the rest brings Byrne into Professor Cassidy's New York gymnasium late in November some 14 months after. He may then place in time the abbreviated but spectacular boxing career of Sailor Byrne from a remark the Professor made after Billy had demolished Cassidy's current white hopeful in a gym bout. Cassidy opined that Byrne "could clean up the Big Smoke if he'll ever come back and scrap". This reference to the absence of Johnson then comes after late June 1913 when he sailed to Europe, slipping the country and his bail after a Mam Act conviction. Johnson didn't have a major fight until June, 1914 when he defeated Frank Moran in Paris. The day after the fight WWI broke out and a lot of people had other things to worry about than the possible return of Jack Johnson.

Sailor Byrne then, immediately went to work as a professional boxer, most likely early in December 1913. He scored a series of impressive victories within a few months until he became seriously considered as a contender, his career being cut short only when he was apprehended as the alleged murderer of Schneider. Cassidy wired a challenge to Johnson, and according to Burroughs, "received an answer that was most favorable", although he was already signed up for Moran. Having met a generally cool reception in Europe and being low in funds, Johnson welcomed any chance to earn a good payday, which he could fighting a popular newcomer with drawing power, such as Byrne. Crowds usually came hoping to see somebody knock Jack's head off. All that remained was the actual signing. What Burroughs didn't say, but was most likely, was if the bout were to be held, in view of Johnson's legal difficulties, it would have to be abroad.

The question may be asked if a young fighter such as Byrne, with comparatively few formal ring bouts and only a few months experience, was being rushed into a meeting with a boxer of the stature of Johnson, and if he would have stood a chance? Well, of course Byrne was not all that much of a novice to the game. His ring experience went back more than four years, and we know that he was a good, tough fighter, young and strong. Johnson himself, also a resident of Chicago, must have seen him in action at the time the Mucker hung out at Larry Hilmore's boxing academy, going into the ring with all sorts and conditions of boxers. Burroughs has recorded that, "The Big Smoke himself had acknowledged respect for that awful right". Professor Cassidy, that shrewd and experienced judge of fighting material saw in Byrne a veritable reincarnation of the younger Jeffries, who won the championship after only twelve fights. Yes, Billy Byrne may very well have been the one to defeat Johnson.

As it was he never got the chance. Johnson went on to Havana where he was counted out lying flat on his back while apparently shading his eyes from the glaring Cuban sun. An oft-reprinted photograph seeming to show this odd and suspect ending has given rise to the derisive belief that he threw the fight. Responsible ring historians however, say that he was given a savage beating by Willard and was legitimately knocked out. Willard himself said, "If he took a dive, I wish he had done it earlier, it was hotter than hell that day".



FANTASTIC FENCING FOLIOS

JOHN HARWOOD

John Carter defeating a roomful of swordsmen! Gahan of Gathol splitting an opponent from crown to chin! Vor Daj lopping off the head of a foe! All these are exciting scenes from the Mars books of ERB. How true to life are they? Not the fact that they are laid on the Red Planet. Not the fact that some of the swordsmen have six limbs. But how true to the facts of life are the feats of these swordsmen?

For an answer to these questions, I asked an old friend who has had some experience with fencing. Dr. Johann Van Marshall is the curator of the Museum of Medieval Weapons located in one of the almost forgotten parts of Greater Boston. The larger museums now attract most of the sight-seers who visit museums at all. However, this institution is still well-known to lovers of old weapons. Indeed, it has now turned into a semi-weapons shop. No longer supported by public subscription, it pays its way by the admission fee charged to those who want to look over its superb collection of old swords, daggers, shield, and other antique weapons. There is also a repair shop where collectors can have items for their collections repaired. For the benefit of collectors there is an exchange club where enthusiasts from all over the country can advertise items that they wish to buy or sell.

It has been several years since I last paid a visit to my friend, but finally a business trip to Boston gave me the opportunity to see him again. As I entered his office he sprang to his feet to greet me. He was seventy-four but he was as agile as a much younger man. He always attributed this to the fact that he had taken up fencing as a young man and had continued practicing for at least an hour a day ever since.

After the greeting were over he led me into the inner office where he entertained his closest friends. This was a small room tastefully decorated with a few gems of his private collection of swords. The sword was his favorite weapon and he never tired of talking about it—its history, its manufacture in the old days, and some of his experiences in fencing.

We had been talking about a number of subjects, when I noticed much to my surprise a collection of Edgar Rice Burroughs books—most of them the Martian tales. Not knowing that he was interested in the author, I asked him about them.

"Oh, those?" he exclaimed. "I call them my fantastic fencing folios."

"Fantastic fencing folios?" I asked, puzzled.

"Yes, fantastic fencing folios," he replied. "If you knew anything at all about fencing you wouldn't be surprised at the term. It would make you shudder to read about some of the feats of swordsmanship accomplished by John Carter and the other heroes of the books."

"Well, I had always wondered at some of the things John Carter could do with his sword," I said. "Sometimes when he could defeat a half a dozen swordsmen single handed I wondered if it were possible for a swordsman to defeat a number of other men even if he were a superior fighter. After all, if you are confronted with six blades coming at you all at the same time you can engage only one at a time. Meanwhile, what about the other five?"

"Exactly. No matter how good a fighter you are you can't fight off more than one blade at a time if your enemies cooperate intelligently. As an example, let me bore you with a tale from my youth. My first fencing instructor was a college senior who was very, very good—he was one of the star pupils of the great Torrigiani and would have made quite a name for himself in amateur fencing if he hadn't had to forfeit his amateur standing to make money for tuition. After our first two or three hours of instruction he decided to enliven the lesson for us with a gimmick or two. (The point of this is that there was far more difference between him and us than there would be between the greatest of professional fencers and any worse than mediocre soldier who had to use a sword as weapon, in that certain elementary points would be learned by the latter in the first couple of weeks' teaching in an era when swords were really used as weapons) The game he played was that we should start out on one side of the gym with two of us (backs to the near wall) facing him and staying directly in front of him. (Otherwise, we would have out-flanked him—which is of course what we would have done in a genuinely homicidal bout) We then were to attack him, while he backed rapidly across the width of the gym to the opposite wall. If he got there first or touched one of us on the way, he won. If one of us touched him before he reached the wall, we won. We started with him doing the only thing to do: backing fast and fencing at terrific speed using either a circular parry (employed when you're in retreat under high pressure and not sure just what thrust your attacker will use—a fine defensive parry but just a little harder than the standard parry to riposte from) or a slashing sidewise parry of great speed punctuated with rapid, almost random, thrusts. The first time he got one of us when he was half way across. The second time he got to the wall before we could touch him. But then I did a little thinking. No object can occupy two places at one time, and no sword can parry two fast lunges delivered exactly at the same moment. We had been fencing cautiously, carefully, and individually—but not cooperating. So before we started the third bout I whispered to my partner to forget the conventions of fencing and to do nothing but thrust, thrust, thrust as fast as he could while I did the same. We touched the instructor before he was one third of the way across the gym. He grinned at me and said, 'Oh, so you've caught on, eh?' and that was the end of that game. From this you can see what would happen to our heroes if they took on ten or a dozen men at once. It could be done only if the Great Swordsman were holding a narrow passage or a stair where only one man at a time could attack him."

"Well," I said, "that seems to take care of that."

"Of course, on Barsoom John Carter could bounce around like a rubber ball, even jumping clean over green men and splitting their skulls on the way (quite a trick, that) so maybe if the room had a very high ceiling and was very big he could have bounded around with such amazing rapidity that he actually engaged only one or two men of the dozen or so at any one time—but it would have been a most undignified spectacle!"

"Yes, I suppose that John Carter's unusual jumping ability would come in handy against the less agile native Barsoomians." I reflected for

a moment, then said, "This brings up another question. Would a natural agility or superior strength give a less skilled swordsman any advantage over a good swordsman? I am thinking now of some of the scenes in the Tarzan series. I think it was in TARZAN AND THE ANT MEN that the ape man was victorious in a sword fight with a skilled fencer. According to the author, he didn't know too much about the art, only something of what Paul D'Arnot had taught him. But this little knowledge combined with his great strength and natural agility enabled him to overcome his foe even though Tarzan was using only an iron rod instead of a sword. His great strength might let him beat back the other man in a clash of blades but would his natural agility enable him to get out of the way of a lightning thrust by the better swordsman?"

Dr. Van Marshall looked at me for a moment, then opened his desk drawer and took out a ruler. He fumbled in the drawer, shifted some papers on the top of the desk and muttered something about, "I was sure I had a couple of rulers around here some place. No matter."

He replaced the ruler, closed the drawer and said, "You can try this with a friend sometime. Take two rulers or sticks and each of you hold one. Cross them, exerting pressure as in a movie scene where two actors have crossed blades and are exerting all their strength while they glare into each other's eyes. This is one of Hollywood's favorite scenes and is simply nonsense to experienced fencers."

"But back to the rulers. You were pressing blades (rulers) strongly with your friend. Suddenly release the pressure you are exerting, at the same time dropping your point slightly to disengage it. Your friend's blade will be instantly carried far to one side by his own strength. Immediately you merely straighten your own arm—and there he is (if you are foolish enough to use the real thing) squirming on your blade, for he can't possibly get his own back soon enough to parry your thrust. In this case, your opponent's superior strength works against himself."

"Now let us take a case of a less skillful foe who adds great agility to superior strength. Permit me to inflict another of the painful Reminiscences of Van Marshall upon you. After several months of our course we were matched against members of the other class. My opponent was one of the first string half backs from the football team, a vast chunk of muscle and lightning reflexes. Now I was a long weedy youth of no athletic abilities and filled with a passionate aversion to all forms of exercise save fencing, which I did rather enjoy. Certainly in that pairing you had a physical disparity as great as any that you find among even fairly healthy people. Yet I polished that side of beef off 5-0 in about two minutes flat, his point never touching me once."

"The reason is quite simple. I spent hours browsing through library books that could be of no practical use. One of them was a history of fencing in which I read of the revolution in fencing technique that occurred around 1800, consisting largely of the development of elaborate planned attacks. One of them was sufficiently simple so that I could see how even I might be able to learn it. It consisted of what you might call a system of progressive feints. A swordsman usually faces his enemy side on with the point of his blade almost directly toward his opponent and on a median line, since that is obviously the best position from which to thrust or parry. The more he moves his sword to one side, the more he uncovers the other side. So you begin an attack with a rapid series of feints and disengages, each

time feinting a little farther toward—for example—the right. Unconsciously, he moves his foil toward the left because all the attacks are from that direction and it is easier for him to parry if his blade is already there. Then on your last feint (say the fifth or sixth) you disengage by dropping your point, swinging it to your left (mere finger pressure does this with a little wrist motion), and lunge home on his uncovered chest. Thus you can see how very slight an advance in technique will overcome a tremendous physical disadvantage."

"I can see now where strength and speed wouldn't give a less skilled fighter any advantage over a good swordsman. Probably ERB didn't know too much about fencing although he did go to a military academy where you might think fencing would be one of the required subjects. Even if he did know something about it he might have ignored the facts to make the stories more interesting. After all, he did ignore a lot of scientific facts in his writings."

I paused for a moment. "This brings up another thing. Or rather two things. Sometimes in the books you read of John Carter or some other warrior lopping off an opponent's head by splitting him from crown to chin or even to his breastbone. I would think this an impossible feat. I don't mean that a man's head couldn't be cut off or split down the middle. Possibly it could be done if you had a sword heavy enough and sharp enough but meanwhile, what of your opponent? I imagine that it would take more than a flick of the wrist to lop off a man's head. To get the greater power for such a heavy blow the swordsman would have to bring his whole arm back and then forward to gain the momentum to sever the bone and muscles of the neck. Meanwhile, what is his enemy doing with such an opening before him? He isn't going to bow his head and wait for the blow. He's going to take advantage of his opportunity, and his point has to move a shorter distance to its target."

"The same is true of cleaving an enemy from crown to breastbone. To achieve this, even more power is needed. The bone of the skull would give much more resistance to the blow of the sword than the bone and muscles of the neck. In this case, the man with the sword would have to bring his sword arm back over his head or shoulder for the powerful downward sweep of the blade. This would leave him wide open to a thrust by his opponent."

"You are quite right about all that," replied Van Marshall. "Swinging the sword back for a tremendous slash would merely give your enemy a splendid chance to puncture you, since all he would have to do would be to straighten his arm—that is, if his sword were (as the Martian ones surely were) at all adapted to thrusting."

"You are also correct about all this head-lopping and splitting to the breastbone. The strength needed for the latter especially would be tremendous. Oh, heads have been sliced off in combat, but the difficulty of the operation you can gather from some of the old accounts of executions. There the headsman was an expert, very strong, facing a kneeling man (not somebody dancing up and down and poking a sword at his tummy), and employing a huge, razor-sharp, two-handed sword or headsman's axe. Normally, the victim's head came off all right, but there are one or two very messy cases recorded when even under these conditions he didn't succeed in cutting through the neck at the first stroke and had to hack away at the poor devil a few more times. In fact, spectators in the jolly sporting fashion of the old days used to bet on whether one slice would do the job. Now I suppose Tarzan (who seems to have been almost

as strong as a gorilla) and John Carter (who had the advantage of great strength plus lighter gravity) could be accepted as having the strength and speed for these activities, but as for ERB's lesser heroes who, as I recall, go in for a bit of this also, I should have my doubts."

"Then you think that John Carter and Tarzan may have had both the strength and speed for this kind of fighting?" I asked.

"Well," said the curator, "there's a remote possibility that they might be able to perform the feats credited to them in the books. Both were unnaturally strong: John Carter, because his Earthly muscles were made more powerful by the lesser gravity of Mars; Tarzan, because his life in the jungle swinging from the trees and battling wild animals would develop muscles much more than in civilized man. Because he grew up among wild animals, Tarzan's reflexes were those of an animal rather than of a human. John Carter's greater speed might come from the same source as his greater strength—the lesser gravity of Barsoom. The muscles of a Barsoonian would have been developed to cope with only Barsoonian gravity. To a Barsoonian, a long sword would weigh a certain amount. The same sword, to John Carter, would weigh much less. Thus, in a fight between John Carter and a Barsoonian with swords of the same weight, the Warlord's greater strength would allow him to move his sword about more quickly than his opponent's just as if it were a much lighter weapon. However, I still have my doubts about the scenes in which Carter overcomes a roomful of swordsmen. I don't think his speed would be great enough to out-manuever six or a dozen points at the same time."

"Now let's take strength alone," I said. "Are some of the scenes possible in which a man with a powerful blow can slice through a large area of bone and muscle? There are a few cases in which a swordsman does just such a thing without having to watch out for his opponent's blade."

The curator reached up and took down a book. "I think I know some of the scenes to which you refer." He leafed through the book until he came to the page he wanted. "It says here——"

"Do you mean to tell me," I interrupted, "that you can turn right to any passage in the books that you happen to think of?"

"Well, no," he replied. "If you were to ask me to turn to a passage where Tarzan kills a lion with his knife or David Innes battles a monster with a spear I couldn't tell you. But mention any sword fight in the books and I can turn right to it. But, as I was saying, it says here in THE CHESSMEN OF MARS that A-sor, the friend of Gahan of Gathol, crept up behind Tara's captor and swung his sword in a mighty blow that split the man's skull and continued on down to his breastbone. As he approached the man from the rear, he didn't have to worry about avoiding the point of his sword when his arm was drawn back for the blow."

"Let me make a note of that passage," I said, bringing out a pencil and a notebook. "Let's see, that was CHESSMEN. And the page number?"

Dr. Van Marshall looked at the top of the page and said, "Page 298. It might be different in another edition."

"Well," I replied, "some of the reprints use the same plates as the first editions so the pages would be the same in each. If there is a different number of pages it probably won't be more than a page or two off."

He put the book back and took down another, this time THE GODS OF MARS. He riffled the pages, then said, "Here on page 13 we have Tars Tarkas splitting a plant man from chin to groin. I wonder if the plant men of Mars had true bones like the humans and other animals? This might account for such a result. If they didn't have bones, there wouldn't be as much resistance to the sword cut."

Another book. (WARLORD OF MARS p. 154) "This one really takes a lot of strength. John Carter and Thuvan Dihn swinging together, decapitate an apt. The nearest thing on Earth to an apt in massiveness would be a hippopotamus. Imagine two men with swords chopping off the head of a hippo."

Dr. Van Marshall picked a book from the shelf and leafed through it.

"Here's another thing that staggers me," he said looking sadly across the desk at me. "In 13th Century England the knights wore heavy armor. Usually they were completely protected from sword thrusts, except possibly through a slit in their visors. The armor of that time usually consisted of one to three thicknesses of chain mail with some use of plate. Yet in this book, THE OUTLAW OF TORN, Norman of Torn is repeatedly burying his sword's point into the hearts of his foes. Incidentally, the swords of this time were cutting weapons rather than thrusting weapons. At this period, swords were used for slashing at the heavily armored foe and for this reason didn't have very sharp edges. After all, how could a razor-sharp sword keep its keen edge after even one blow against unyielding iron or steel? Even a modern steel knife has to be sharpened every so often when being used of softer substances than steel."

"Although the 13th Century sword was a cutting weapon, Norman of Torn in most of his fights fences in the style of a 19th or 20th Century maitre des armes, using the point in by far the majority of cases!"

"That's a point that escaped my notice," I remarked. "It's been quite a few years since I read the book but I should have thought it odd that the Outlaw was able to drive the point of his blade through steel-clad chests of knights in full armor."

From here on the conversation drifted to other non-Burroughs subjects with which I will not bore the reader. When I got back home after my week in Boston I reread one of the Mars books to see if my conversation with Dr. Van Marshall had spoiled the books for me. Much to my surprise, in spite of the fact that my friend had found so much fault with the swordplay in the books, I found that I enjoyed the story as much as ever, for when ERB begins to weave one of his tales, the mundane laws of swordsmanship, physics, and general reality quietly vanish beneath the bright colors of high romance.





CONCERNING "TARZAN AND THE CASTAWAYS"

No individual is infallible, and I stand to be corrected if my belief concerning the book version of "Tarzan and the Castaways" -- which is Edgar Rice Burroughs' original story -- should prove wrong.

Comparing the book with the version that appeared in the three issues of *Argosy* magazine from August 23rd to September 6th, 1941, under the title, "The Quest of Tarzan," the reader does not need go beyond the first chapter of the latter before he is aware of the altered and additional text. It is known that the author did not give his consent to changing the original title of his story. "The Quest of Tarzan" confuses many readers, who consider it to be the same as "Tarzan's Quest" (which appeared in book form in September, 1936). However, the two stories are utterly different in concept.

In the last half of the first chapter of the magazine version, we find a dozen more or less lengthy paragraphs that concern Tarzan's suffering a loss of memory just before being captured by Arabs. Personally, I rather enjoyed this additional material, which is only hinted at in the book -- where, in its stead, we have two pages in which Janette Laon and Fritz Krause are discussing the captive wild man who is to be brought to the tramp steamer *Saigon*, anchored at Mombassa.

In the latter part of Chapter IV of the magazine version we have more additional text: Abdullah, a rascally Arab who was instrumental in Tarzan's capture, and two confederates bring a boa constrictor to the iron cage wherein Tarzan and Janette Laon are confined. They feel sure the ape-man and the girl will be killed, but Tarzan slays the python instead. The first four paragraphs in the next chapter of the magazine relate that the ape-man has recovered his memory, and knows his identity. I regret that this was not included in the book version, which touches sketchily on the subject, as it gives a more thorough understanding of the situation.

The remainder of the story, even though slightly altered by minor omissions in the magazine, continues as the book version except for the last page. The yacht *Naid*, which had been chartered by some English people on an expedition, and which earlier in the story had been taken over by mutineers, is sighted heading for shore. In the final paragraph of the *Argosy* version, Tarzan wades out into the sea and swims toward

the vessel. The book version reveals that the yacht had anchored, and the last page implies that all is well.

I shall not go into the details of the story itself. Let me just say the author has written another fine, hair-raising adventure, even though Tarzan is far removed from his native Africa to a South Pacific island.

The book version is the smoother reading of the two; however, the additional material that the magazine contained would have made my joy complete. How Mr. Burroughs managed to keep track of the numerous characters in the book, with their outstanding characteristics, without any confusion, is beyond my comprehension. He must have had each one blue-printed before a certain number of them were eliminated in accordance with their just dues. Reading this short Tarzan novel convinces me more than ever that Mr. Burroughs possessed a keen mind in his ability to create ever-new situations, with nothing overlooked.

Now let me explain what I meant in my opening paragraph.

It is my opinion that "Tarzan and the Castaways" was written as a motion picture, rather than as a regular novel. The author had written others in the past, notably "The Lad and the Lion," "The Man Eater," and "The Oakdale Affair." So it would not be amiss to infer that this was precisely what he had in mind in writing this Tarzan story. Perhaps at the time he was becoming somewhat disgusted with the current Tarzan pictures, and decided to try his hand at writing such a script in novelized form.

When a reader finishes the book version of this novel and pauses to consider it carefully, I think he will agree that it has all the necessary elements to make a very exciting motion picture. In addition to the hazards of shipwreck, we meet a lost tribe of Mayans upon a South Pacific island, still practicing their ancient beliefs in this modern age.

I think Sy Weintraub should read this story and give it serious consideration as a "new" sort of Tarzan adventure. It would not fail to captivate the movie patrons, who unquestionably would hail such a motion picture with unbounded joy.

—Maurice B. Gardner



Tarzan knew that that earlier rescue would have been in vain if the Mayan girl was once more to be led to the altar

ON PELLUCIDARIAN GEODESY

BY FRANK J. BRUECKEL

1

ON page 23 of FELLUCIDAR there is given a map of that portion of the earth's inner surface called the Empire of Pellucidar (Fig. 1).

As we know from the story, after his return to the inner world David Innes constructed this chart by a rather rough-and-ready method. There was no careful measurement of distances and directions, no use of accurate surveying instruments and precise mathematical formulae. Innes employed an ordinary magnetic compass to fix directions for his own observations, and a pedometer to provide a rough estimate of distances; various details he filled in simply from verbal information supplied by Pellucidarian tribesmen. There is no indication that he utilized any particular cartographic projection in representing the curved, spherical surface of Pellucidar on a plane sheet of paper. At best, the map can be regarded as only an approximate picture of Pellucidarian topography in a rather restricted region.* No doubt it was a useful and quite satisfactory guide

for his own peregrinations about the Empire, for even a faulty map is usually better than no map at all; but surely there must be some distortions of scale and orientation as one moves away from "Greenwich", the point at which Innes established his basic directions and distances. However, there is no scale given with the map, nor does Innes tell us where any of the important points in the depicted area are situated with respect to the planet's outer surface.

Nevertheless, it is possible to deduce certain basic facts from the features shown on the chart. Of primary importance is the shaded circle called the Land of Awful Shadow, which lies directly beneath the Dead World, Pellucidar's little "moon".

We can surmise, first of all, that the map in Fig. 1 is approximately orthographic in its central regions — say from the peninsula of Amos down to the shore of the Sojar Az, and from the Anoroc Island Group leftward to the Lidi Plains. In this portion we may suppose the distance-scale to be essentially uniform in all directions and the relative positions of topographical features to be correct. To get an idea of the proper scale of the map we have the fol-

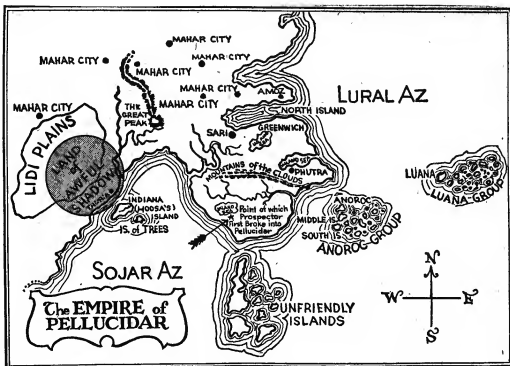


Fig. 1

* There is a puzzle too about how this map came into ERB's possession in the first place. It was not drawn until after Innes's return to Pellucidar, a number of months following his one and only meeting with Burroughs in the Sahara. The story FELLUCIDAR was transmitted by telegraph "several years" later. If the published map was made by ERB on the basis of a description furnished by wire, we have additional cause to question its accuracy. However, in the absence of definitive contrary evidence I will assume that the map in the book agrees completely with the one made by David Innes.

lowing statements, all from FELLUCIDAR, as guides:

"North Island" is some 10 or 20 miles from "Greenwich" (p. 22). Hence the Darel Az, in which the island lies, must be 20 to 40 miles wide at this point; let us say, roughly, 30 miles.

The "Great Peak" is a good hundred miles from Sari (p. 133). The river which starts at the foot of this peak flows into the Sojar Az some 40 miles from Thuria (p. 133). "As the crow flies it is about 20 miles from the mouth of the river to Thuria" (p. 138).

From these data we estimate the diameter of the Land of Awful Shadow to be around 100 miles, which thus establishes the approximate scale of the map.

Now we come to a supremely significant point.

The plane of the inner moon's orbit around the central sun coincides with the plane of the earth's equator -- that is, the equator bisects the Land of Awful Shadow. For, since the satellite hangs always over the same spot on Pellucidar's surface, not oscillating north and south in its 24-hour revolution around the inner sun, the plane of its orbit must be perpendicular to the earth's axis, around which the planet itself turns with the same period as the Dead World. But the law of gravitation requires that this plane also contain the attracting center, viz., the inner sun which is at the very center of the planet. The only plane satisfying both conditions -- perpendicularity to the planet's axis and passing through the center -- is the equatorial plane.

This brings up a rather disconcerting problem. If the map in Fig. 1 is to be regarded as fairly accurate, and if the circular shadow has a diameter of about 100 miles, then the distance from the center of the shadow to the point X where the iron mole first entered Pellucidar is only some 200 miles -- and this represents the maximum possible distance of X from the equator. Actually, if the directions shown on the map are correct, it appears that the equator must pass very near the Mahar city of Phutra, and north of the point X by 60 miles or so.

Now in Chapter I of AT THE EARTH'S CORE we are not told from just where on the outer surface the first journey was begun. Innes's references to his New England background may lead one to assume that he and Perry started their trip from somewhere in Connecticut or Massachusetts, but if so, the iron mole moved through the earth's crust not vertically, but in a long arc starting at about lat. 42° N and ending within one degree or so of the equator -- a distance of at least 2600 miles, rather than 500 as their instruments registered (see Fig. 2).

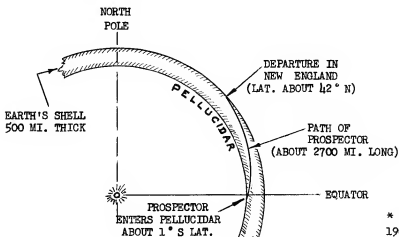


Fig. 2

Consequently, in this event, the speeds and distances mentioned in the account of the trip are completely unreliable. But if we accept that the prospector bored straight down through the earth's shell for 500 miles before emerging into Pellucidar, then it must have begun its epochal journey from a point on the outer crust only about one degree from the equator.

Africa and South America suggest themselves as likely regions. On the return trip to the outer crust (AT THE EARTH'S CORE, last chapter) Innes left Pellucidar from the point of his first arrival, and

emerged on the (presumably southern) edge of the Sahara. He says that the return trip was evidently along a less perpendicular path than the first, but it can hardly have been extremely so; it follows that the point X in Pellucidar must be somewhere beneath Africa, near the equator. I conclude that Innes and Perry started their voyage of discovery from equatorial Africa, probably the southern Cameroon area--admittedly a most unlikely place to build and test a huge, complex mechanical monster like the iron mole! But this hypothesis alone appears to be reasonably consistent both with the narrative and with the inflexible laws of celestial mechanics.

We have found the approximate scale of the map in Fig. 1, and placed the Land of Awful Shadow on the equator. But the directions shown on the map are incorrect--the one labeled "east" is actually "west", and vice versa.

It is easy to see how this conclusion arises. Suppose you stand erect, facing due north, with your arms outstretched sideways at shoulder level. South is behind you, your right arm points east, your left arm west. Imagine David Innes standing in Pellucidar, 500 miles straight below you, facing in the same direction as yourself, i.e., toward the north. His feet are toward you; relative to you he is hanging "upside down" from the earth's inner surface. Therefore his outstretched right arm points in the same direction as your left arm, that is, toward the west, while his left arm points east, as does your own right arm. Fig. 3 may make this clear. Here we are looking at a cross-section of the hollow earth from a point directly above the North Pole. In Pel-

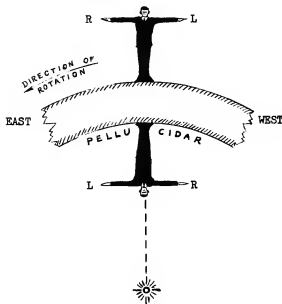


Fig. 3

* Especially when we consider that the year was 1903. Burroughs met Innes in 1913, at which time Innes remarked that he had spent ten years in the inner world. See AT THE EARTH'S CORE, p. 3. Also in LAND OF TERROR, p. 9, Innes says that in 1939 he had been in Pellucidar for 36 years.

** The presence of the Polar Opening mentioned in TANAR OF PELLUCIDAR and TARZAN AT THE EARTH'S CORE (and presumably a corresponding opening near the south pole) insures that the earth's magnetic field in Pellucidar has the same direction as on the outer crust. In the absence of these openings the magnetic field inside the earth would be directed oppositely to the outer field, and what Innes took as north on his map would actually be south. See Appendix I.

lucidar the directions east and west are reversed relative to north and south. Had Tines considered this fact when drawing his map, he would have shown directions as in Fig. 4a. By force of habit, however, he placed "east" to the right of the N-S line, as we do on our outer world maps (Fig. 4b). If the earth's crust were transparent, an observer on the outer surface would draw a map of the Empire of Pellucidar as shown in Fig. 5. (I am disregarding probable inaccuracies of scale near the edges.)

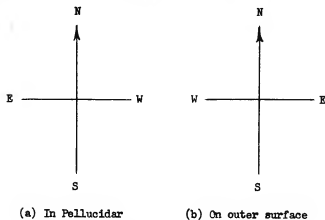


Fig. 4 - Orientation of directions

2

The original map of the Empire of Pellucidar is in the lower half of the more extended chart published in Blue Book magazine to accompany TANAR OF PELLUCIDAR (Fig. 6). In this latter chart we note something which clearly shows that the area depicted is far greater in extent than one would judge from the picture. To the north of the city of Korsar is the shore of the "ice bound ocean" which, according to the story, leads through a Polar Opening to the outer surface. If provisionally we assume the scale of this map to be uniform in all directions, and take the radius of the Land of Awful Shadow as 50 miles,

then the frozen shore of the ice-bound ocean is roughly 670 miles from the center of the Land of Awful Shadow, or only about 11° from the equator — palpably an unrealistic situation.*

The only reasonable conclusion is that the Blue Book map is grossly distorted in its upper half — the scale — unit must decrease drastically as we move up toward the top border of the chart.

This fact naturally raises the query what cartographic projection might plausibly be represented by Fig. 6. To put it another way, what sort of grid should we superpose on Fig. 6 so that the Land of Awful Shadow, with its diameter taken as 100 miles, lies athwart the equator while the ice-bound ocean is shown at some high latitude, 5000 or more miles away?

We have to be very careful. If the shore of the ice-bound sea is on the lip of, or possibly within, the North Polar Opening, then the spacing of parallels and meridians in its vicinity becomes a tricky business, due to the sharp curvature of Pellucidar's surface as it goes through the Opening to meet the outer surface of the earth. The surface of the planet within the Polar Opening is like the inner half of a torus ("doughnut"), convex in the north-south direction and concave in the east-west direction. Each meridian leads to a different "north pole", and along the "equator" of the Opening the meridians are closer together than at the "poles" — quite the opposite of what we have on a sphere. The "parallels of latitude" within the Polar Opening constitute a separate system from those on the rest of the earth. (Similar remarks would of course apply to a presumed South Polar Opening.)

We are told in TANAR, Chapter XIV, that from the shore of the ice-bound sea David and his companions could see the outer world's Sun on the horizon before them. To understand the implications of this statement, examine Fig. 7. David and his party could have been standing at point A, where Pellucidar begins to curve into the Polar Opening, and seen the outer Sun by light which just grazed the far side of the Opening at point B. (For simplicity's sake we here ignore the ray-bending effect of atmospheric

* In Pellucidar, with its radius of 3500 miles, one degree of arc is about 61.1 miles.

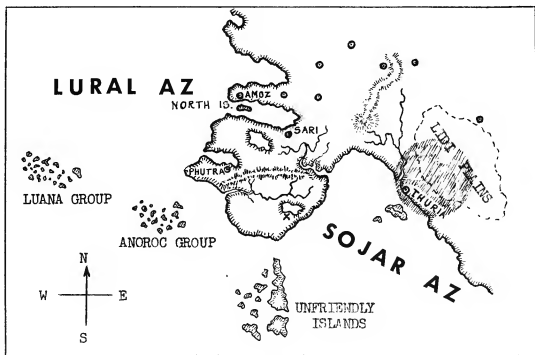


Fig. 5



Fig. 6

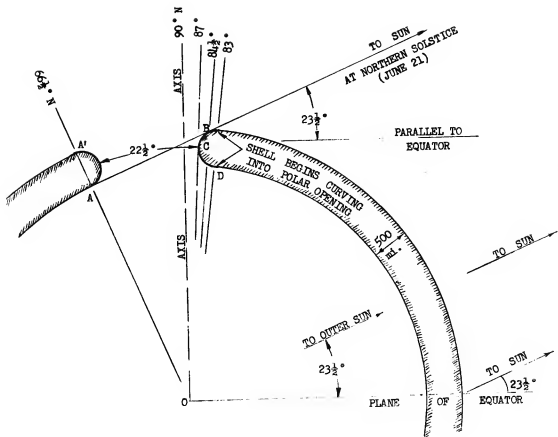


Fig. 7

refraction.) Assuming the most favorable case, that the date was about June 21, so the Sun at the time was at its farthest north of the equator ($23\frac{1}{2}^\circ$), the observers must then have been standing vertically below the Arctic Circle, at lat. $66\frac{1}{2}^\circ$ N. From the geometry of the situation, taking the thickness of the shell as 500 miles, the Polar Opening at its narrowest must be about $22\frac{1}{2}^\circ$ wide, or some 1475 miles in diameter. But if David was at A when he looked upon the outer Sun, he would still have had the inner sun directly overhead at O. This was not the case, for we are also told that as the fugitives approached the northern sea the Pellucidarian sun fell behind them and sank ever lower in the sky. Hence they must have passed the inner verge of the Opening and been going up over its lip toward the planet's outer surface.

But now a new and extremely tricky complication is introduced by the earth's rotation on its axis. Depending on the size of the Opening and the latitude of its center, the time of year when David and his friends were within it, and their particular position at a given time, the outer Sun could sometimes be visible to the explorers and sometimes not; it could be very low above their horizon or very high, even overhead; at a certain time of day (near midnight of the corresponding meridian on the outer crust) both suns might even be behind the party -- the inner sun motionless on the horizon, the outer Sun not very far from the zenith. The detailed analysis of this problem, while straightforward in principle, looks so forbiddingly lengthy and fraught with opportunities for error that I am discouraged from attempting it. So, to provide an excuse for avoiding it, I will assume that the Polar Opening is always so filled

with heavy cloud banks that the outer Sun's rays can never penetrate across it.* We may then suppose that Innes and his friends went virtually clear through the Opening and finally saw the outer Sun from point B (on the "day" side of the earth's axis) of Fig. 7. The ice-bound ocean of Fig. 6 is therefore actually on the earth's outer surface.

A straight line from O through B makes an angle of about $5\frac{1}{2}^\circ$ with the earth's axis, so we may say that B is at lat. $84\frac{1}{2}^\circ$ N. (As the outer surface begins to dip into the Polar Opening at 83° N, perhaps point B should properly be located by the Opening's own system of latitudes.) Astronomically, position B is equivalent to A or A'; i. e., an outer-world explorer reaching B would think he had crossed the North Pole and was now on the Arctic Circle, at $66\frac{1}{2}^\circ$ N.

A straight line from O tangent to the Opening at C makes an angle of 3° with the Axis; we will say, for convenience, that C is at lat. 87° N. Now this is the closest approach that the earth's surface makes to the axis on which the planet turns, hence by the system of coordinates used outside the Opening there are no latitudes higher than 87° .

If the fugitives from Korsar were at point B when they stood on the "southern" (actually northern) shore of the ice-bound sea, then it is not necessary for the Polar Opening to be as large as shown in Fig. 7. We can assume that it is symmetrical around the earth's axis; at its narrowest then it will be 6° or about 393 miles in diameter.

Returning to the Blue Book map, Fig. 6, suppose we

* See also "Note on the Atmosphere of Pellucidar," Appendix 2.

start at the center of the Land of Awful Shadow (a point we henceforth call the Origin) and proceed in a vertical line northward. The Origin is on the equator, so as we move north our latitude increases progressively. At about 83° N we are at the inner verge of the Opening (point D in Fig. 7), but our latitude continues to increase until we are at 87° N (point C, Fig. 7), halfway through the Opening. At this point Pellucidar's sun (O in Fig. 7) is on the horizon behind us; the outer Sun is still far below the horizon ahead. We push on along the short arc from C to B in Fig. 7; once we pass C we may consider ourselves as being on the earth's outer surface and our latitude is now decreasing. Neither sun is above our horizon now when we are on the same side of the earth's axis as the outer Sun, because we are then on the shadowed side of the Opening; when the planet's rotation has carried us around to the opposite side of the axis we would actually see the outer Sun high in the sky, were it not for the dense cloud layers within the Opening. Nevertheless, from the account in Chapter XIV of TANAR it seems that we receive some dim, diffused illumination from the inner sun, and may even continue to see it for some distance due to refraction of its rays around the curve of the Opening, i.e., it might appear to be still on our horizon. Also the outer Sun may contribute a smidgen of light by reflection from the clouds overhead or by filtering through them.

About 260 miles past C we reach the shore of the ice-bound ocean at B, and see the outer Sun on the horizon ahead. Our latitude is 84½° N, and the sea stretches away before us southward on the planet's outer surface. Some 130 miles beyond B is the outer limit of the Polar Opening, at approximately 83° N.

From these considerations it is evident that a small portion of the map in Fig. 6, below the ice-bound ocean, must be regarded as lying within the North Polar Opening.

Suppose we choose an arbitrary point on our Prime Meridian (the vertical line through the Origin) a little below the arctic ocean — say about midway between it and the mountains north of the Korsar Az — to represent the point D of Fig. 7. This point is at latitude 83° N, and we are particularly interested in devising a suitable coordinate system for the region south of this latitude.

After mulling the problem over for several days and experimenting tentatively with a number of special projections, none of which proved satisfactory, I resorted to a simple nomograph to construct a latitude-scale for Fig. 6 meeting three essential requirements: (1) the center of the Land of Awful Shadow (the Origin) is on the equator; (2) the radius of the Shadow is about 5/6 degree of arc; (3) a preselected point on the Prime Meridian — which on the Blue Book map I took at 4.2 inches up from the Origin — marks the latitude of 83° N where Pellucidar's surface begins to curve into the North Polar Opening. By imagining the bottom of the Opening to be closed over by a smooth continuation of Pellucidar's surface, the meridians in Pellucidar can be considered to meet the earth's axis, and the latitude-scale can be extended to 90°. The scale is shown in Fig. 8.* We see how latitudes crowd together as we move northward on the map — the first 8° of latitude cover about as much vertical distance on the map as the remaining 75° to the limiting parallel for which the scale is valid.

The next question is to decide whether to regard Fig. 6 as some form of cylindrical projection (the class to which the famous Mercator projection belongs) or as some type of azimuthal projection. In the former case the parallels of latitude will be straight horizontal lines and the meridians equispaced straight vertical lines, with the degree of

longitude practically equal to the first degree of latitude. Then the east-west extent of the map is about 12-3/4°, representing a distance of over 800 miles along the equator and about 95 miles along the 83rd parallel where the degree of longitude spans a bit less than 7½ miles. At high latitudes any equatorial cylindrical projection stretches east-west distances enormously, so they appear far greater on the map than they really are. This elongation of east-west distances, if combined with a drastic compression of north-south distances, produces an extremely distorted picture of the regions around the Polar Opening.

Upon some further mulling, I have elected to regard Fig. 6 (or the portion of it south of the 83rd parallel) as a special azimuthal projection centered on the Land of Awful Shadow. An azimuthal projection is symmetric about its center, so all lengths measured from the center will undergo the same distortion in whatever direction they are taken — hence we can measure all distances from the center using our latitude scale. All points of a circle concentric with the Shadow are at the same arc-distance from the Origin. All straight lines passing through the Origin represent great circles on the surface of Pellucidar, therefore we can use our latitude scale to measure airline (great circle) distances in degrees of arc from the center of the Shadow. Thus we find at once, for instance, that the city of Korsar is 30° of arc or 1833 miles from the Origin as the proverbial crow flies. Two points on the same radial line from the Origin are separated by a distance equal to the difference in their arc-distances from the Origin O; for example the straight line joining Korsar to O cuts the coast north of the Lidi Plains at a point h' from O, so the width of the Korsar Az along this line is 30° - h' = 26° of arc, or somewhat over 1588 miles.* (If the two points are on opposite sides of the Origin, we add their respective arc-distances from it to get the great circle distance between them. Thus the deserted Mahar city on the northeastern edge of the Lidi Plains is about 1.7° from O; Thuria is about 0.5° from O in the opposite direction. The shortest distance from Thuria to this Mahar city is thus about 2.2° or roughly 13½ miles.) For two points P and P' which are not on the same line through the Origin O, we can measure their respective distances L and L' from O with the latitude scale, and the angle θ at O between the lines L and L' with a protractor; this gives us two sides and the included angle of a spherical triangle. Then the great-circle arc s between P and P' can be found (in angular measure) by the formula from spherical trigonometry:

$$\cos s = \cos L \cos L' + \sin L \sin L' \cos \theta. \quad (1)$$

For instance, let the points P and P' be, respectively, the village of Sari and the western tip of Amcoap Island, for which we have the respective distances from O: L = h', L' = 10°. The measured angle at O between these lines is θ = 74°. Therefore

$$\begin{aligned} \cos s &= \cos h' \times \cos 10^\circ + \sin h' \times \sin 10^\circ \times \cos 74^\circ \\ &= (.99756)(.98461) + (.06976)(.27365)(.27564) \\ &= .98575, \end{aligned}$$

whence, looking up this number in the cosine column of a table of trigonometric functions, we have

* To facilitate conversion of angular distances to miles, the following table is given (based on a radius of 3500 miles for Pellucidar):

10° = 10.181 mi.	50° = 3054.35 mi.
10° = 610.87 "	60° = 3665.22 "
20° = 1221.74 "	70° = 4276.09 "
30° = 1832.61 "	80° = 4886.96 "
40° = 2443.48 "	90° = 5497.83 "

* See Appendix 3 for principle of construction.

$$s = 9^{\circ} 41' = 591.5 \text{ miles}$$

as the shortest distance from the western end of Amiocap to Sari.

By imagining Pellucidar's meridians to continue across the polar aperture to meet the earth's axis under the celestial North Pole, our Prime Semi-Meridian will of course measure just 90° from Origin to Pole. If we measure the line L joining a point P to the Origin, and the angle α around O from the Prime Meridian to the line L, we again have two sides and the included angle of a spherical triangle. The fact that one of these sides is 90° greatly simplifies the usual formulae for the solution of spherical triangles. Let the point P of the map be at lat. ϕ , long. λ ; then we find in fact

$$\sin \phi = \sin L \cos \alpha; \quad \sin \lambda = \tan \phi \tan \alpha. \quad (2)$$

With L and α determined by direct measurement, we can then find ϕ and λ from a table of trigonometric functions. For example, we found that for the city of Korsar, $L = 30^{\circ}$; the angle α between the Prime Meridian and the line Korsar-Origin measures 19° to the nearest whole degree. Hence

$$\sin \phi = \sin 30^{\circ} \cos 19^{\circ} = (.50000)(.94552) = .47276,$$

$$\therefore \phi = 28^{\circ} 13', \text{ approx.};$$

$$\sin \lambda = \tan 28^{\circ} 13' \tan 19^{\circ} = (.53657)(.34433) = .18476,$$

$$\therefore \lambda = 10^{\circ} 39', \text{ approx.}$$

Korsar therefore lies at a little over 28° north latitude and not quite 11° east longitude.

When the latitude scale is laid along the equator (with zero at the Origin, of course) its graduations mark the corresponding meridians from 0 to 90° east or west. (This is the reason for extending the scale to 90° , though as far as latitudes are concerned it is good only to 83° .) If around the Origin O we strike a circular arc of radius 90° by our scale, this arc cuts through the "Unknown Lands" in the upper left and upper right corners of Fig. 6. The left-hand portion of this arc is the meridian 90° east of the Prime Meridian through O; the right-hand portion is the meridian lying 90° west of O. Consequently the regions lying beyond (above) this arc are in the opposite hemisphere to that which is centered on the Land of Awful Shadow, and any radial line from the Origin which crosses this arc tends southward beyond the 90th meridian.

Suppose for instance we draw a straight line from the Origin O to the extreme upper right corner of Fig. 6. This line represents a great circle through O, but a great circle through any point of a sphere also passes through the antipode of that point, i.e., the diametrically opposite point of the sphere. Thus, all straight lines through O on the map represent great circles which pass through the point of Pellucidar diametrically opposite the Origin, at lat. 0 , long. 180° , which we call the Antipode, A. (If the map were sufficiently extended the antipodal point A would be shown as a circle centered at O, with a radius of twice 90° on our scale.) Every point of the meridian 90° W of O is 90° from O, and also 90° from A, so if we reverse our scale at this meridian, placing the 90° -mark on it, we find that the upper right corner of the map reads a little under 20° — that is, this corner is (nearly) 20° from A. The angle α between the Prime Meridian and our line measures $32\frac{1}{2}^{\circ}$; this means that this great circle crosses the 90th meridian at $32\frac{1}{2}^{\circ}$ from the Pole, or at lat. $57\frac{1}{2}^{\circ}$ N, and makes an angle of $32\frac{1}{2}^{\circ}$ with the 180th meridian at the Antipode. (The angles between two great circles at their intersections are equal.) Since the Antipode is 90° from the Pole, we

once more have two sides (20° and 90°) and the included angle ($32\frac{1}{2}^{\circ}$) of a spherical triangle having one vertex at A, another at the North Pole, and the third at the point marked by the upper right corner of the map. Therefore we can use Eqs. (2) to determine the coordinates of this point, remembering, however, that our reference-point now is the Antipode A. For this reason we replace the longitude λ in the second of these equations by the colongitude χ , which is the angle between the 180th meridian and the meridian passing through the point of interest. Thus the actual longitude (from the Prime Meridian) of the given point will be

$$\lambda = 180^{\circ} - \chi. \quad (3)$$

In the present case we find then:

$$\sin \phi = \sin 20^{\circ} \cos 32\frac{1}{2}^{\circ} = (.34202)(.84339) = .28846,$$

$$\therefore \phi = 16^{\circ} 46';$$

$$\sin \chi = \tan 16^{\circ} 46' \tan 32\frac{1}{2}^{\circ} = (.30128)(.63707) = .19194$$

$$\therefore \chi = 11^{\circ} 41',$$

$$\lambda = 180^{\circ} - 11^{\circ} 41' = 168^{\circ} 56'.$$

The meridian passing through our point of interest is west of O; thus the upper right corner of Fig. 6 represents the point at lat. 17° N, long. 169° W, in round numbers.

Clearly the same procedure can be employed to find the locations of other points of the map beyond the arc of the 90th meridians, subject to the condition that α be at least 7° so that the lines from O will not pass above lat. 83° N, where the Polar Opening invalidates our formulae.

We find, for instance, that the "ice bound ocean" does indeed extend down through the Polar Opening into Pellucidar, in the Antipodal Hemisphere. A line from O to the left-hand extremity of the sea, at the top border of the map, makes an angle α of about $11-1/3^{\circ}$ with the Prime Meridian, and upon reversing our scale at the 90th meridian East, we find that it reads 50° at the point in question — i.e., this point is 50° of arc from the Antipode. In the same manner as above, we obtain

$$\phi = 48^{\circ} 41' \text{ N}; \quad \lambda = 166^{\circ} 49' \text{ E.}$$

It must be pointed out, however, that this result reposes on the assumption that the map in Fig. 6 is quite correctly drawn on the projection and scale here adopted. Actually this is extremely unlikely, for Innes's knowledge of the regions around the Polar Opening was obtained during his flight from Korsar with Tanar, Ja, Stellara, and Gura. He had neither the equipment nor the scientific detachment to undertake anything like an accurate survey of the country he traversed, and it is to be expected that his depiction of these remote areas is far from reliable. So I am quite unwilling to put much faith in the map beyond the arc of the 90th meridians. But certainly our Arctic Ocean does somewhere reach down through the Polar Opening to meet one of Pellucidar's own broad seas, because the 16th century ancestors of the Korsars no doubt reached their present country entirely by sea from the outer world; and in SAVAGE PELLUCIDAR the little old man whose name is not Dolly Dorcas entered Pellucidar in a small boat, coming far enough through the Polar Opening to reach a land supporting fruit-bearing vegetation.

To construct a properly deformed latitude-longitude grid for Fig. 6, we return to Eqs. (2), solving them in reverse order for α and L when ϕ and λ are specified. Thus, to locate the intersection of the parallel of lat. ϕ with the meridian of long. λ , we have first

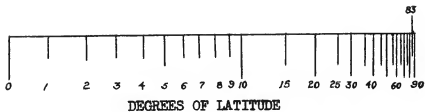


Fig. 8: Latitude scale for Pellucidar map, Fig. 6

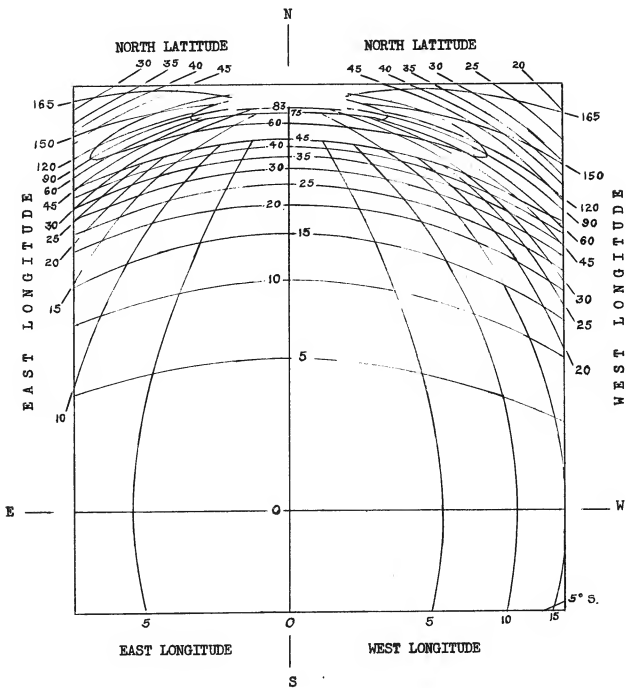


Fig. 9: Coordinate grid for Fig. 6

PEL

Scales:
Outer crust 0 500 1000 1500
Pellucidar 0 500 1000 1500
miles

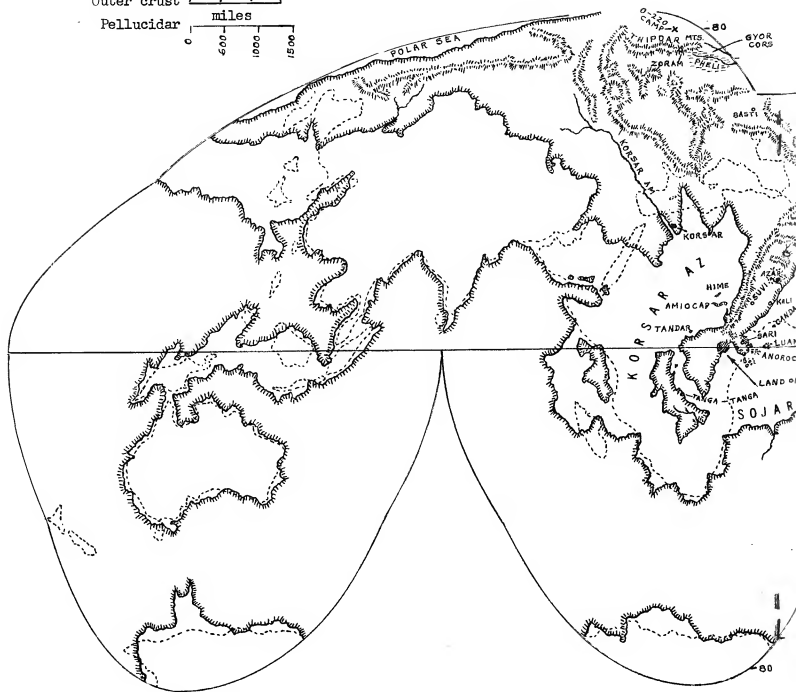


Fig.

PELLUCIDAR

GODDARD HOMOLOGOUS EQUAL AREA PROJECTION

Scales:
Outer crust
Pellucidar

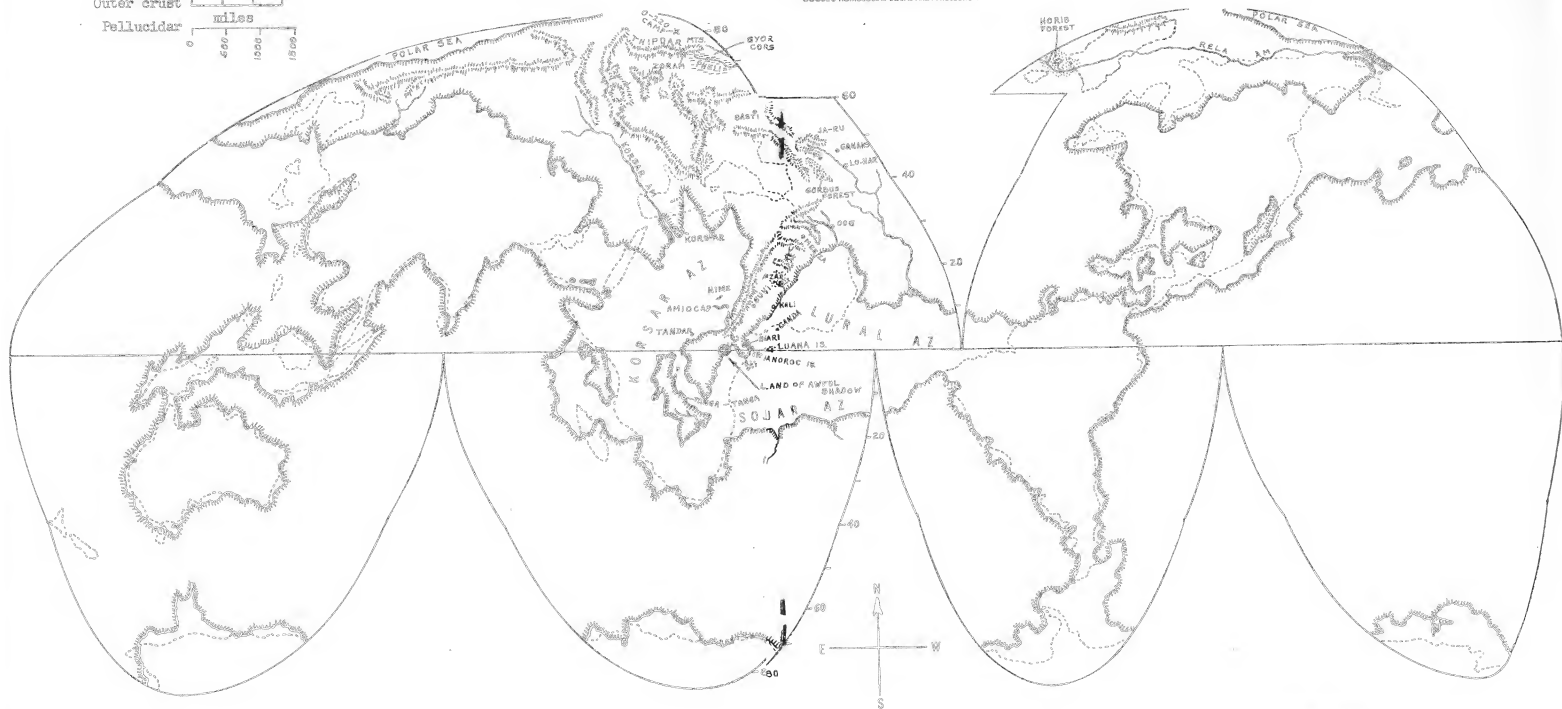

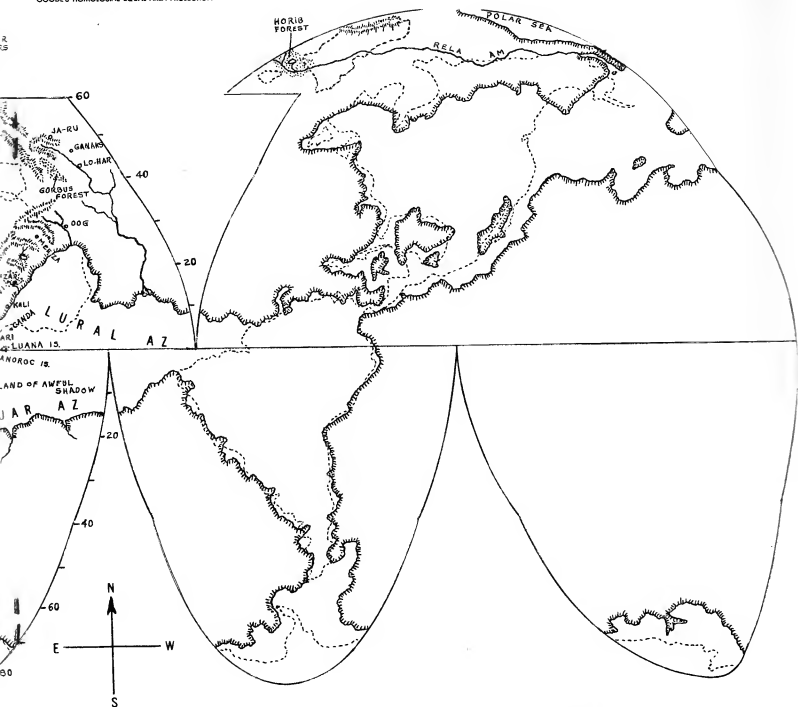


FIG. 13

Fig. 13

ILLUCIDAR

GOODE'S HOMOLOGOUS EQUAL AREA PROJECTION



FJB 1965

Fig. 13

$$\tan \alpha = \sin \lambda \cot \phi,$$

and find α in a trig table; this gives us the bearing of the required point from O. Next,

$$\sin L = \sin \phi \sec \alpha,$$

and looking up L in the table gives us the arc-distance we must measure from O with our scale in the proper direction to arrive at the desired point. The result is shown in Fig. 9, which may be traced on transparent paper and overlaid on Fig. 6.

3

Because of the great reduction in scale in the upper parts of Fig. 6, this map does not show fine detail north of the Korsar Az — we see only that between this ocean and the Polar Opening there lies an extensive mountain massif arcing roughly half way around the Opening. As this is the general scene of the events narrated in TARZAN AT THE EARTH'S CORE, it may be worth while to attempt some depiction, on a larger scale, of the region where the O-220 expedition experienced its adventures.

From pp. 22-23 of TARZAN AT THE EARTH'S CORE we know that the great dirigible did not fly far into Pellucidar before coming to earth; after emerging from the Opening the ship crossed a range of wooded hills and a broad forest, then anchored on a wide, well-watered plain. The purpose of the stop was to give everyone some much-needed rest, to do some preliminary exploration in order to become acquainted with the conditions in the inner world, and to plan just how to effect the rescue of David Innes from Korsar. Obviously it would be foolish to penetrate any considerable distance into Pellucidar until these essential preliminaries had been settled; therefore the O-220's first landing must have occurred within a few hundred miles of the Polar Opening. Evidently it was a little south of 83° N, the latitude which marks the limit of the Opening, because at this position the ship had the stationary inner sun at the zenith—and this is true only for points within 83° of the equator. Before leaving the O-220 in the scout plane to search for the missing members of the party, Gridley mentioned (TAETEC, p. 85) that with the fuel the plane could carry he would be unable to travel more than about 250 miles (about 4° of arc) from the dirigible and return to it. He had just about reached this limiting distance when he had his disastrous encounter with the pterodactyl at the foot of the Mountains of the Thipdars (p. 87). Clearly therefore, the Mountains of the Thipdars are part of the great montane complex north of the Korsar Az in Fig. 6.

Unfortunately, we do not know whether these mountains more or less completely encircle the Polar Opening, for as already pointed out, the top center part of Fig. 6 is a representation of the inside of the Opening and a part of the earth's outer surface; the portion of the Antipodal Hemisphere of Pellucidar between 173° E and 173° W is hidden from us, and we must consider the possibility that it was in this region that the O-220 landed. But this eventuality is unlikely.

Let us return for a moment to the first map, Fig. 1, and bisect the Land of Awful Shadow with a horizontal line representing the equator. We note that both "Greenwich" and the point of the prospector's first arrival in Pellucidar are about 1° from the equator, which passes between them. These two points are roughly 125 miles apart, and if the iron mole's path through the crust was nearly vertical each time then the points of departure on the outer crust are themselves at most only a couple of hundred miles apart and probably also on opposite sides of the

equator. I suggested before that the point I believe Cameroon, and we know that "Greenwich" must lie under the Sahara — but the southern edge of the Sahara is a thousand miles north of the equator. We can only conclude that the prospector's routes through the crust were considerably off from the vertical — which in turn implies either that the crust is much less than 500 miles thick, or else (and far more likely) that the instruments in the vehicle registered much less than the actual distance traveled. Nevertheless it is evident that the Empire of Pellucidar lies below western equatorial Africa, so we will not be too far amiss if we locate the center of the Land of Awful Shadow at about 15° E longitude from Greenwich, England, so the Mahar city of Fnutra is very nearly directly under Libreville, Gabon.

Now, when the O-220 undertook its voyage of rescue to Pellucidar, the plan had been to follow the 10th meridian east of Greenwich (England) north to the pole (TAETEC, 19). In order not to attract too much attention, a slight deviation westward was made, so the dirigible passed to the west of Spitzbergen and entered the Polar Opening along about the 5th meridian E of Greenwich, or possibly along the Prime Meridian itself. When Lt. Hines announced (p. 19) that by his calculations they had reached the North Pole, the ship was actually only a little more than 83° N by the outer world's system of coordinates and about 100 miles "north" (really south) of the shore of the ice-bound ocean which Innes had reached. With the Polar Opening encircling the earth's axis, every meridian leads to a different "North Pole", for the "Pole" is now not a single point, but a circle of some 450 miles radius around the true Pole (the point in which the axis pierces the imaginary continuation of the planet's surface across the Opening). It is not surprising then that the crew of the O-220 could discern no sign of the previous visit of the Italian Norge to the "North Pole", for in all likelihood the two vessels had reached different "Poles".

Upon leaving the "Pole" the O-220 pursued its southerly course along the 170th East Meridian (p. 20). But in reality the ship was now already moving down into the Polar Opening, and what the navigator took to be the 170th East Meridian was actually the 10th meridian east of Greenwich, England — in other words, the dirigible was following a course which, going over the lip of the Opening, curved back almost under the path by which the Opening had been approached. (I don't know that a diagram would make the situation any clearer. Perhaps the best procedure is to visualize a hollow glass school globe with an opening having a smoothly rounded edge around the upper end of its axis; then in imagination trace a line northward across the outside of this globe, into the opening, and back down the inside, shifting direction about 10° to the right as you go into the opening.) It follows from this that as the O-220 emerged from the Opening into Pellucidar, it must have been flying southward nearly along our Prime Meridian through the Land of Awful Shadow. Consequently the area in which the events of TARZAN AT THE EARTH'S CORE transpired can be placed in the mountainous region north of the Korsar Az in Fig. 6. The O-220 came to ground on the plain north of these mountains at about lat. 80° N, the northern flank of the Mountains of the Thipdars being at about 75° or 76° N.

To obtain some idea of the relative locations of the places mentioned in the story, we have the following passages as clues:

P. 129-30: "As Tarzan, Tar-gash and Thoar followed the spoon of Jason and Jana a disheartened company of men rounded the end of the great Mountains of the Thipdars, fifty miles to the east of them, and entered the Gyor Cors, or great Plains of the Gyors." (This party consisted of Von Horst and the ten Waziri. Strangely, the book relating Von Horst's adventures, BACK TO THE STONE AGE, does not speak of this

particular incident, but seems to imply that Von Horst was carried off by the huge trodon before the Wasiri reached the Gyor Plains.) As Tarsan and his comrades were in the Mountains of the Thipdars at the time, this indicates that the Gyor Plains lie at the eastern end of these mountains.

P. 254: "Rising at the east end of the Mountains of the Thipdars, a river flows in a southeasterly direction entering upon its course the gloomy forest of the Horibs . . . it was along the upper reaches of the same river that Tarsan and Jana were being conducted downstream toward the village of the lizard-men.

"The lake of the Horibs lies at a considerable distance from the eastern end of the Mountains of the Thipdars, perhaps five hundred miles . . ."

The most immediate problem facing us here is how to interpret the word "east"—for as we saw in Sec. 1, "east" and "west" in Pellucidar are opposite to these respective directions on the outer crust. However, men of the outer world have a deeply-ingrained habit of placing "east" to the right when they are facing north, and I suspect that our narrator fell into the same error. Hence, in constructing a chart of this area of Pellucidar it seems to me we must put the Gyor Plains to the right (west) of the Mountains of the Thipdars if we call the top of the map "north". The river down which Tarsan and Jana were taken thus runs generally southward and toward the right on our chart. This river is a tributary of the Rela Am, which runs through the swamp of Phell and along which Jason and Thoar were taken by their Korsar captives. The Phellian swamp thus lies to the south of the Mountains of the Thipdars. Farther to the southwest lies the Gloom Forest and Lake of the Horibs. Concerning the positions of the chiefdoms of Zoram, Clovi, and Daros, we know that all three are in the great Mountains of the Thipdars, and that Zoram lies between the other two, for Ovan told Tarsan (p. 184) that Daros lies beyond Zoram from Clovi. Also we are informed (p. 191) that the Gyor Plains lie at the end of the range "beyond Clovi." Hence Clovi is the westernmost of the three countries, and we recall that when Tarsan and Jana escaped from there they descended to the Gyor Plains with the thought of then turning back along the foot of the mountains until they would be directly below Zoram. (p. 222).

(AUTHOR'S NOTE: I have just received in the mail the final issue of Dale Brodurst's Burroughs Reader & Thuria, containing an excellently done map of Pellucidar by Bruce Wood. While it is immediately evident that Wood and I are not in agreement on a number of important points, I see that he has anticipated me in several procedures, surmises and conclusions. As I still have a goodly portion of the present article to write, I shall endeavor not to let Wood's chart influence my own reasoning, but will strive to work solely from the notes and sketches I have already prepared and am in process of compiling from the Pellucidar books. But I wish here to compliment Mr. Wood on a very fine job. ---FJB)

We are not informed in what direction the Rela Am flows, but we know that it does not pass through the Lake of the Horibs -- otherwise the Korsar band that followed it upstream and captured Jason and Thoar would never have reached the Phellian swamp. It is likely, however, that the lake feeds its waters to the Rela Am through a tributary stream.

My natural inclination is to suppose that the Rela Am flows generally southward to empty into the Korsar Az, but the information supplied by the Korsar sailor Lajo makes it clear that this is not the case.

Sari, says Lajo on page 278, after the party's escape from the Horibs (when they are perhaps five

or six hundred miles southwest of Zoram) is a long way from here, and the journey leads across the Korsar Az. But from Fig. 6 we see that a direct land-route leads down almost straight southward to Sari from the mountain massif of which the Mountains of the Thipdars are a part. If the country of the Horibs is near these mountains one should be able to reach Sari by simply skirting the western shore of the Korsar Az. But remember that this was unfamiliar country to Lajo, and while he would know in what direction Korsar lies from his present position, his notions of how to reach Sari from here would be pretty uncertain. His natural tendency would be to think of how to get to Sari from his native Korsar, and this indeed would require crossing the Korsar Az (unless one wanted to follow the long coastline around). On p. 282, after the party has followed the Rela Am down to the ocean, Lajo assures them that Korsar lies on this same land-mass, and we read:

"What lies in that direction," he said, pointing south, "I do not know, but there lies Korsar, upon this same coast," and he pointed in a direction a little east of north. (Emphasis mine.) "Otherwise I am not familiar with this sea, or with this part of Pellucidar, since never before has an expedition come as far as the Rela Am."

One must conclude from this that the Rela Am does not flow into the Korsar Az, for although it is hardly to be expected that the Korsars have thoroughly explored the great ocean on which their city lies, surely Lajo would realize that he is on the shore of the Korsar Az if this were actually the case. In pointing southward he would know that he is indicating the approximate direction of Sari, and that one can get there by simply following the western shore of the sea nearly to the Land of Awful Shadow; moreover in indicating the direction of Korsar he would point, not "a little east of north," but southeastward (which he and the others would of course regard as southwestward) across the sea.

It appears that the Pellucidarian's inborn homing instinct leads him to point to his natal hearth along the lesser arc of the great circle which joins him to it. Direct confirmation of this surmise is provided in BACK TO THE STONE AGE, p. 113, where Laja tells Von Horst that where terrain permits she travels toward her native land "in a straight line," i. e., along the arc of a great circle. Hence, when Lajo pointed out the direction of Korsar as "a little east (actually west) of north," he must have been pointing past the North Polar Opening* --- and this means obviously that the mouth of the Rela Am is on the other side of the Pole from Korsar, in what I call the "Antipodal Hemisphere" of Pellucidar. Since it is my argument that the Mountains of the Thipdars are themselves in the "Primary Hemisphere," I must infer that the area in which the events of TARZAN AT THE EARTH'S CORE occurred forms an arc around the Polar Opening, and that the eastern shore of the Korsar Az below Korsar turns rather sharply northeastward to lead up to the Rela Am. Because of Pellucidar's everlasting high noon it is---as our narrators frequently point out in the books---extremely difficult to judge large distances; consequently we have only the haziest notion of the length of the Rela Am. Apparently it is considerable, yet I doubt very much that the mouth of the river lies below 60° N lat.

In regard to the places in which Von Horst's adventures took place, as recounted in BACK TO THE STONE AGE, we suffer a handicap in the fact that we

* This suggests a most interesting question: does a Pellucidarian's homing sense still operate if this great circle lies across the Polar Opening itself, i. e., if it passes within, say, three degrees of the planet's axis? See also Appendix L.

do not know where the trodon's crater-lair is situated with respect to the initial landing place of the O-220. Let's see if we can make some reasonable guesses.

To start, we know that quite near the O-220's "base camp" there is a large forest (suppose we call it "Forest of the Tarags") containing the glade into which the hunting sabre-tooths drove their prey, and where Gridley became separated from Von Horst and the Waziri. This wood lies north of the Mountains of the Thipdars. Now in TARZAN AT THE EARTH'S CORE, we read that Von Horst and the Waziri "rounded the end of the Mountains . . . and entered the Gyor Cors;" but in BACK TO THE STONE AGE no mention is made of this incident -- it would appear that Von Horst and the Waziri wandered aimlessly about in the same forest until Von went alone in pursuit of a boar and was seized by the weird reptile-marsupial called the trodon. I presume that soon after Von and the Waziri met, following their first separation, they came to the edge of the Gyor Cors, realized that they must be going the wrong way from the O-220 (probably because they saw the mountains so close beside them) and headed back into the wood. Von must have disappeared very soon thereafter. Hence the Forest of the Tarags evidently extends southwestward from the O-220 base camp, closely approaching the western end of the Mountains of the Thipdars and probably marking the northern boundary of the Gyor Cors. Following Von Horst's disappearance the Waziri wandered on, eventually meeting Tarzan and Gridley near the shore of the Lake of the Horibs, several hundred miles southwest of "home". I suspect therefore that the Forest of the Tarags reaches virtually unbroken all the way to the Forest of the Horibs, which bounds the Gyor Cors on the southwest. It was, then, somewhere in the Forest of the Tarags, westerly of the Gyor Cors, that Von was captured by the trodon. In what direction the creature then carried him, or to what distance, we do not know. Apparently it was a very considerable distance; yet wild creatures as a rule confine their routine activities of hunting and mating to the smallest area which will fulfill their requirements. The trodon that captured Von Horst, while perhaps ranging much farther from its lair than most predators for the satisfaction of its needs, is not likely to have carried him over a few hundred miles -- say five or at most ten degrees of arc -- from where it seized him.

There is good reason to believe that the trodon's lair and the villages of Basti, Ja-ru, and Lo-har are all in the "Unknown Land" lying to the north of the Lural Az in Fig. 6. Dangar, whom Von Horst met in the trodon's nest, is from Sari, which lies very near the equator in Pellucidar's Primary Hemisphere. We are never informed what mission brought him into the region where the trodon captured him, but it is generally true that primitive hunters rarely wander extremely far from their native countries. If we generously grant our particular trodon a hunting range of 10° of arc (about 600 miles) from its lair, and assume that it caught Von Horst at lat. 70° N, say due north of its nest, then its lair would be at about 60° N. Suppose it seized Dangar at the southern limit of its hunting territory, at about 50° N. This means Dangar must, at the time of his capture, have been some 3000 miles from home -- an extraordinary distance for a lone Stone Age man to roam from his native village.

Basti and Ja-ru, land of the Mammoth Men, are not extremely far from the trodon's nest, for Skruf the Bastian was being hunted by Mammoth Men when Von Horst encountered him near the trodon's crater. Basti and Sari lie in the same general direction (i.e., essentially southward) from the trodon's nest (p. 56, BACK TO THE STONE AGE), and we are also told (p. 101) that Ja-ru, Lo-har, and Sari are in the same general direction -- again southward, clearly --

from Basti. After the escape of the slaves from Basti, Thorek the Mammoth Man was the first to turn off from the trail toward Sari being followed by him, Von, La-ja, and Dangar. This trail runs between a range of high hills on the one hand and the Forest of Death on the other; and Dangar said (p. 104) that at the end of the range he must turn toward the right, while La-ja indicated that she must pass directly through the grim wood of the Gorbuses to reach Lo-har. As they were moving more or less southward, this means that Dangar had to bear toward the east at the southern end of the range, while La-ja had to turn sharply westward. After escaping the Gorbuses, Von and La-ja found themselves on the further (i. e., western) side of the Forest of Death. Frug and Skruf, upon kidnapping La-ja, then turned left toward Basti, and had to cross the valley where Von made friends with Old White, the mammoth. Crossing the river which runs through this valley, Von and Frug were captured by the Mammoth Men and taken to nearby Ja-ru, which thus evidently is situated to the southwest of Basti. The village of the "Bison Men", the Ganaks, is obviously somewhere between Ja-ru and Lo-har. Fig. 10 presents my rough visualization of the general area which is the scene of events in TARZAN AT THE EARTH'S CORE, BACK TO THE STONE AGE, and LAND OF TERROR. Here I have sought to indicate locations only approximately, using an azimuthal "equidistant" projection centered on the North Pole. In this projection the meridians of longitude are straight radial lines issuing from the Pole, while parallels of latitude are concentric circles whose radii are proportional to the colatitudes, or polar distances (i.e., 90°-latitude). The whole region of Von Horst's experiences following his escape from the trodon's nest covers but a tiny area above the letters "UN" in the upper right of Fig. 6.

In the final pages of BACK TO THE STONE AGE we are told that when David Innes and his Sarians reached the vicinity of Lo-har in search of Von Horst they came from the south, which shows again that Lo-har lies in the same hemisphere as Sari, for if David's company had crossed the 90th meridian West into the Antipodal Hemisphere they would have approached Lo-har from an easterly or even northeasterly direction. It was to the south, then, that Innes and his warriors returned after meeting Von Horst.

The area of David's adventures as related in LAND OF TERROR is evidently near the northeastern corner of the Lural Az (the "Unknown Ocean" in Fig. 6, which is known to the Ruvans as the Bandar Az), where the Great Peninsula begins to stretch southeastward between the Lural Az and the Korsar Az. Lo-har is somewhere between 40° N and 50° N, and the northernmost point of the Bandar Az reaches the 25th parallel North, so there are, say, 20° of latitude, or 1200 miles, between Lo-har and the shore of the Bandar Az. This agrees with David's statement (LAND OF TERROR, p. 15), "We made long marches after leaving Lo-har, sleeping quite a number of times." He mentions that before his capture by the bearded warrior women of Oog while crossing a wide river which "flowed sluggishly . . . down toward some unknown sea" (no doubt the Bandar Az), he and his men had traversed a great plain and a forest "beyond which we could see mountains in the far distance." These mountains may well have been a branching range of the Terrible Mountains mentioned in SAVAGE PELLUCIDAR. As a captive in Oog, David met Zor of Zoram, who in pursuit of the abductors of the girl Rana had "covered an enormous distance -- perhaps two or three thousand miles" (p. 13) before his capture first by the Jukans and then by the Oogans. Zoram is at about 75° N; if Zor travelled virtually due south for 3000 miles, or so this would have brought him down to about 25° N lat., or near the northern shore of the Bandar Az. After their escape from Oog, David and Zor were taken by the mad Jukans to the village of King Meesa, where

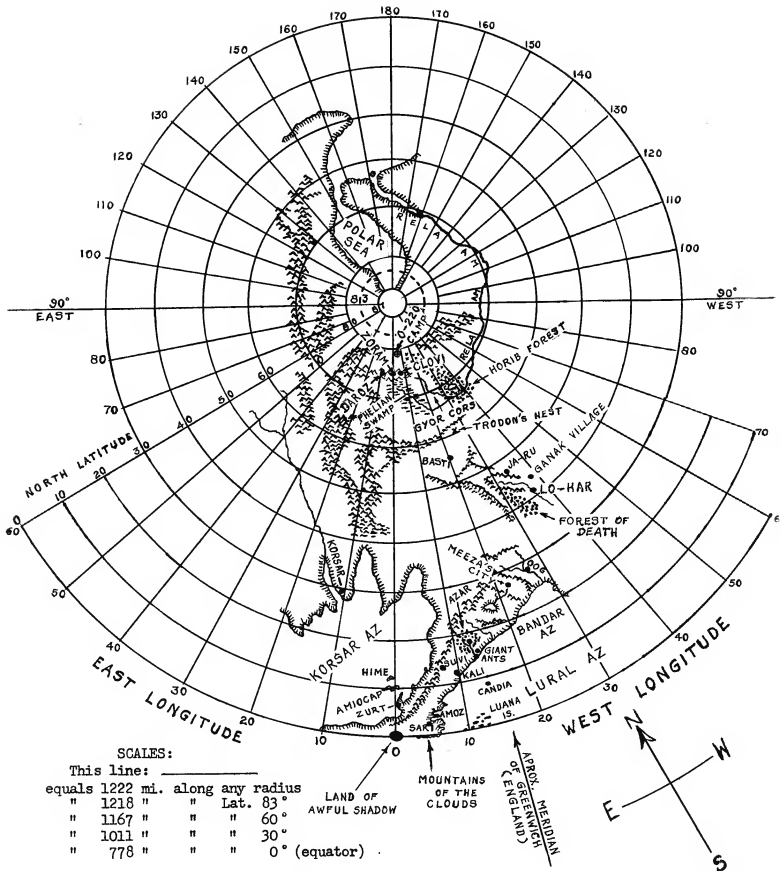


Fig. 10

they met the Suvian girl Kleeto. Suvi is a kingdom on the northern frontier of David's empire, and although Kleeto was undoubtedly a long way from home--perhaps as much as a thousand miles--it seems quite apparent from the story that the country in which its events transpired lies near the northern end of the Great Peninsula.

4

The third and last Pellucidar map available to us is that printed on the endpapers of the Canaveral edition of SAVAGE PELLUCIDAR (Fig. 11). This chart bears the notation, "Coastal details and locations traced from sketches and notes by Edgar Rice Burroughs." One may presume that Mr. Burroughs based his sketches on information obtained through Jason Gridley, who in turn must have received it from Innes or Perry via the Gridley Wave wireless.

Evidently this map is drawn on a pole-centered equidistant azimuthal projection like Fig. 10. A distance scale is provided which shows uniform intervals of 500 miles. Such a scale is, of course, useful only along radial lines from the center of projection, i.e., along Pellucidar's meridians in the present case. But on applying this scale to the Prime Meridian (which I take to be the one passing through the Land of Awful Shadow, not the one through "Greenwich") we find that the center of the Shadow is less than 2400 miles from the Pole, whereas it should actually be 5498 miles; for there is no getting around the point that the Shadow lies squarely across the equator. The Shadow comes out to over 300 miles in diameter, rather than about 100 as in Fig. 1. We note further that in Fig. 11 the Prime Meridian (through the Shadow) passes some distance west of the island of Amocap (misspelled "Amiolap" on the Canaveral chart), whereas in Fig. 6 it cuts across the western side of Amocap. In Fig. 11 the angle at the North Pole between the meridians passing through the Origin and through "Greenwich" measures 20°, which means that on this map "Greenwich" is at long. 20° W of the Origin, while in Figs. 1 and 6 the longitude of "Greenwich" is between 13° and 5° W of the Origin. In view of these discrepancies I feel that, first, the scale given with Fig. 11 must be disregarded completely, and second, the North Pole should be placed much further up on the chart. Moreover we see that in many minor details Fig. 11 does not quite agree with Figs. 1 and 6, even when allowance is made for the difference in projection; so it becomes a question which of these maps is to be regarded as the most accurate representation of Pellucidarian topography. Of the three, Fig. 1 is the largest in scale and the most meticulous in detail, and is therefore undoubtedly the most nearly precise. Fig. 6 is probably a more reliable representation than Fig. 11 of the islands of Amocap and Hime, and the stretch of continental coast to the west of these islands. However, I feel that we should not place too much confidence in Fig. 6, since very little of the area shown was actually explored by Innes. After he and his friends escaped from Korsar, as recounted in TANAR, they travelled far north, actually coming nearly completely out of the Polar Opening as we saw in Sec. 2; then they turned back, threaded the mountainous country in which the O-220 party later had its adventures, and came back down nearly to the northern shore of the Korsar Az. But here, we may remember, David, Tanar, and Stellara were recaptured by the Korsars--though Tanar and the girl later escaped and reached Sari. Thus the delineation of the upper reaches of the Great Peninsula hinges upon what information was brought to Perry by Tanar, Ja, and the two girls; but these persons, being Pellucidarians of Stone Age culture, would not be greatly

concerned with a precise survey of the land through which they passed. The proportions of the Great Peninsula northward of the Empire are therefore open to question, and it is practically certain that more careful exploration would justify extensive redrafting of this region.

In SAVAGE PELLUCIDAR, pp. 10-11, we are told that it is 150 miles from Sari to "Greenwich", 200 miles from Sari to Amoz. But clearly these are not airline distances, for from Fig. 1 we see that from Sari to "Greenwich" can hardly be over 75 miles in a straight line, nor is the great-circle separation between Sari and Amoz more than 100 miles. The narrator must therefore have been referring to marching routes, which twist and turn, go uphill and down, and could easily be twice as long as the airline distances. Our narrator (note, incidentally, that SAVAGE PELLUCIDAR is not a verbatim account given to us directly by Innes, but is related by one or both of the intermediaries, Jason Gridley and Edgar Rice Burroughs) tells us that the village of Kali lies 600 miles "northeast" of Sari, and that Suvi is 400 miles "westerly" of Kali. To what sort of route is the speaker referring here? Generally, the easiest and most direct way from Sari to Kali would be by sea, as David and Ghak went; and this way roughly approximate the airline route. I believe we may safely surmise that the arc-distance between Sari and Kali is some 8° or 9°, or roughly 500 miles. On the other hand, if the overland route from Kali to Suvi is 400 miles, then in all probability the great-circle distance between these places is not over 300 miles or about 5° of arc. Between Suvi and the east coast of the Peninsula lies the long chain of the Terrible Mountains, and apparently there is a rather broad coastal plain between these and the Korsar Az. This suggests that the width of the peninsula here must be around 500 miles.

There are other points on which I incline to disagree with the SAVAGE PELLUCIDAR map. For instance, it shows the village of the Zurts virtually due north of the Land of Awful Shadow, but from Fig. 6 this must be just about where the Korsars landed in their abortive invasion of the Empire; it was from here that Tanar sailed as a hostage on the Cid's ship and was followed by David and Ja. It was on this stretch of coast that Ghak built a fleet to pursue the Korsars and rescue his son and his emperor. Yet in TANAR we find no reference to the Zurts or their village, though there would certainly have been contact between them and the people of the Empire if their country were situated where Fig. 11 indicates. Moreover it is evident from SAVAGE PELLUCIDAR (as well as from the fact that they are not mentioned in TANAR) that the Terrible Mountains do not extend down between this bit of coast and the Ildi Plains. The main part of the range must lie farther to the north and west, and since the land of the Zurts is seemingly near the loftiest portion of the mountains, I place Zurt further up the coast, on the "turkey leg" cape that juts out toward Amocap in Fig. 6.

It was near Zurt that Hodon and O-sa were finally reunited and were accompanied by Jaln's warriors to the foot of the Terrible Mountains, probably due west of the village. From here they followed the range toward the northwest for some distance before meeting the Sarians and Mezops under David, Ghak and Ja, who had turned back from farther north. The party then travelled nearly 2500 miles (SAVAGE PELLUCIDAR, 271) back to the southern end of the mountains, down to the Ildi Plains, westward to the Sojar Az and up to Sari. This would suggest that Zurt is rather far up the coast, yet we know it is south of the parallel of Kali, because O-sa and Hodon moved northward after leaving Zurt for Kali.

I feel quite sure that Fig. 11 is definitely wrong in showing the Xezot city of Tanga-tanga situated at the back of a large bay, for when O-sa drifted

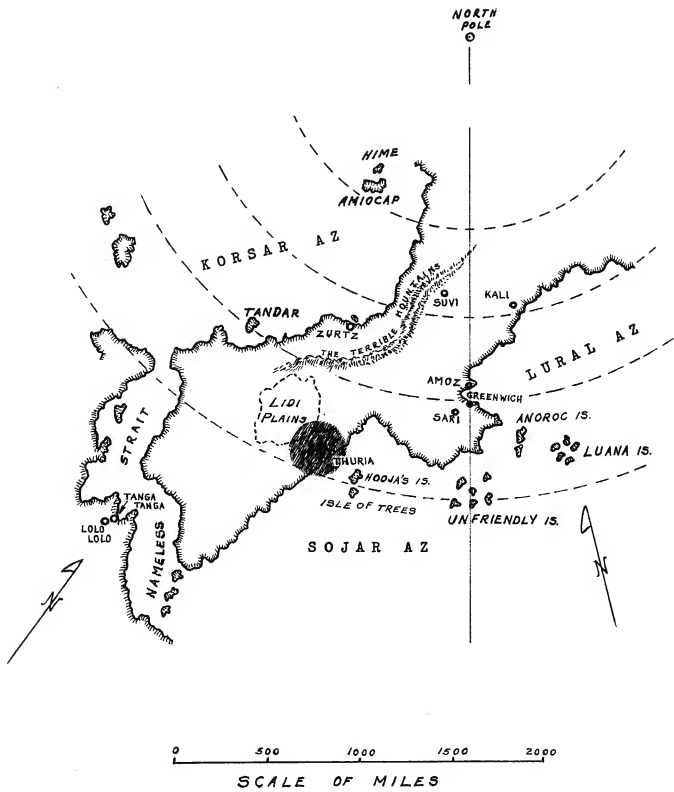


Fig. 11

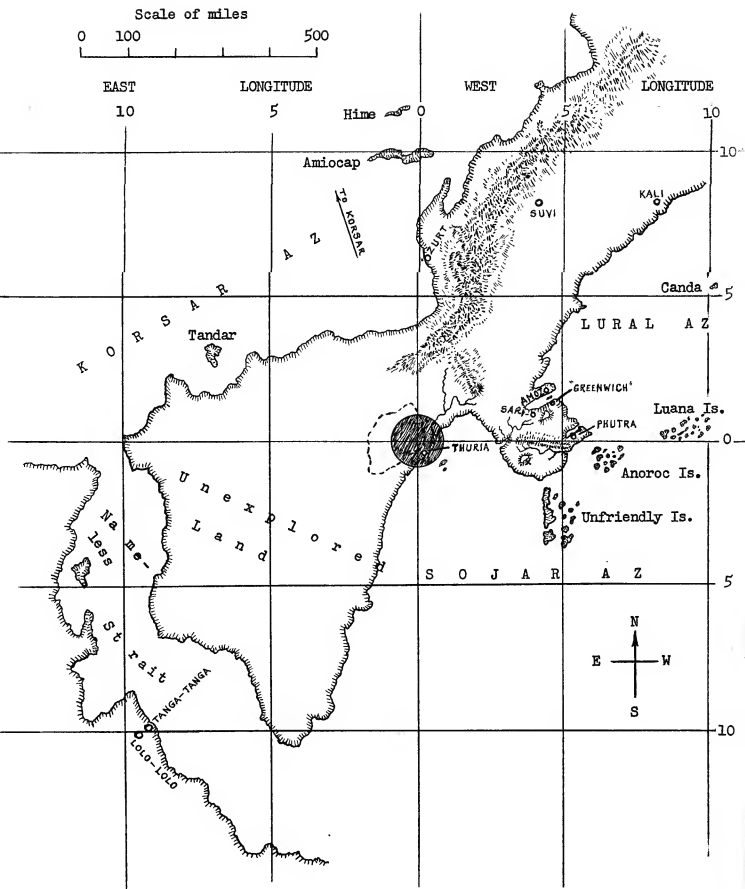


Fig. 12

through the Nameless Strait on the disabled Sari she would have missed the city had it been so located; similarly, later on the John Tyler would have sailed past the bay, probably without ever sighting the city.

Again, I am doubtful about the existence of the several unnamed islands shown on the map, particularly the three which stretch across the lower end of the strait, for there is no mention of these islands in the book. Even more questionable are the two large islands shown in the Korsar Az to the north or northeast of the Nameless Strait, for there is no suggestion in the story that any of the parties that navigated the strait came anywhere near these islands -- so how would the mapmaker know of them?

In Fig. 12 I have redrawn the lower portion of the Great Peninsula, i. e., the region shown in Fig. 11, with the object of securing somewhat better agreement with Figs. 1 and 6 in shape and scale, and of removing the most doubtful features of Fig. 11. For ease in plotting positions I have here taken what is called a "simple cylindrical" projection, in which both meridians and parallels are equally-spaced straight lines. In such a projection the distance-scale is not everywhere uniform, but since the map does not extend more than 15° from the equator, no grievous error will result from using the scale given on the chart.

5

To draw a map which purports to be an accurate representation of the whole surface of Pellucidar is not possible in our present state of knowledge. Nevertheless, in Fig. 13 I venture to offer a highly conjectural picture of the inner world. According to Abner Perry, Pellucidar's continents correspond more or less to the oceans of the outer world, and its oceans to our continents. Innes is not entirely convinced of this relationship, for in LAND OF TERROR, p. 201, he says:

... my assertion that three quarters of the surface of Pellucidar is land ... was based solely upon Perry's theory that depressions upon the outer crust were protuberances upon the inner crust, so that the land areas in Pellucidar corresponded roughly with the oceans of the outer world; but ... that is only a theory, and I do not know that it is true.

However, from AT THE EARTH'S CORE, p. 86, Perry's "theory" is more than a mere guess, for as a slave in Phutra he found a map of the inner world in the Mahar library, and we read:

... he showed me a map of Pellucidar which he had recently discovered among the manuscript he was arranging.

"Look," he cried, pointing to it, "this is evidently water, and all this land. Do you notice the general configuration of the two areas? Where the oceans are upon the outer crust, is land here. These relatively small areas of ocean follow the general lines of the continents of the outer world."

It is a great pity that this map, which was doubtless far more complete and accurate than anything subsequently drawn by Innes, apparently never came into Perry's possession again after the defeat of the Mahar nation. We may feel sure, nonetheless, that Perry's observation was correct, and that there is at least some rough correspondence between outer continents and inner oceans.

We find some slight corroboration of Perry's "theory" in our own deductions concerning the location of Pellucidarian regions. It is clear that the con-

inent from which the Great Peninsula extends is situated under our Arctic Ocean, Europe, and the North Atlantic; the Peninsula itself reaches from the vicinity of Morocco southeastward across the western Sahara and the region of the Niger into the Congo Basin and somewhat beyond. The Lural - Sojar Az is under the western bulge of Africa and the tropical Atlantic, perhaps broadening out to the westward into a greater ocean underlying most of the Americas. On the opposite side of the Great Peninsula we have the Korsar Az reaching up across the Sudan, the central Sahara, and the Mediterranean to about the southern shores of Europe. The city of Korsar is approximately vertically below the Siwa Oasis on the Egypt-Libya border, some 7° south of the island of Crete. Most of Asia, from the tundra of northern Siberia down across China and the Himalayas to the Indian Ocean, is in Pellucidar no doubt occupied by what is probably the inner world's greatest ocean.

Fig. 13 is drawn on Goode's homolousine equal-area projection, which covers the entire surface of a sphere with relatively little distortion of shape save in high latitudes. To indicate the position of Pellucidarian places relative to the outer surface of the earth, I have dotted in the outlines of the outer continents and a few of the larger islands. Because Pellucidar's diameter is only 7/8 that of the outer surface, any line drawn on this chart represents but 7/8 as much distance on the Pellucidar map as it does on the outer-crust (dashed outline) chart. Thus, the linear scale of the outer-world chart is about 1600 miles to the inch; that of the Pellucidar map approximately 1400 miles to the inch. However, any point of Fig. 13 represents two points on the same radius of the earth, one in Pellucidar and the other on the outer crust, vertically above the first. Hence despite the difference in scale, the two surfaces are shown in true positional relationship to each other.

Again I must warn the reader that this map of the inner world does not pretend to be correct and final. That portion of it which has previously been shown in Figs. 1, 6, 10, and 12 is probably reasonably reliable; the remainder is my own fanciful and perhaps very faulty construction based on Perry's assertion that there is an approximate correspondence between inner oceans and outer land-masses.

Obviously a great deal of research remains to be done before we will have a really trustworthy map of Pellucidar; and most of this work must take the form of physical exploration and surveying of the inner world. I believe there is at this time an expedition at the earth's core, comprising the four celebrated scholars and men of letters, C. B. Hyde (commanding), V. Coriell (guide and white hunter), William Gilmour (chronicler), and Stanleigh Vinson (angel and technical consultant). It may confidently be expected that these skilled and objective observers will bring back a wealth of scientific and geographical data about the interior world, unless the aims of the expedition become diverted from the pursuit of knowledge to the pursuit of Pellucidarian cave girls. I rather wish they had asked me along.



Magnetic Field in Pellucidar

I have said that in the absence of the polar openings the direction which Innes marked "north" on his map would actually be "south". Let us see how this conclusion arises.

Innes took as "north" the direction indicated by the north-seeking pole of his magnetic needle. But in the first place the earth's magnetic poles do not coincide with the ends of the axis on which the planet turns, so "magnetic north" does not generally agree with true north. Hence the north-south line shown on Innes's map (Fig. 1) is in all probability several degrees off from the true north-south line lying parallel to the earth's axis,* and this in turn means that his east-west line, perpendicular to the N-S direction, is not parallel to the planes of the equator. However this is a minor point, hardly worth quibbling over. A much more serious error of the map would lie in the fact that, were it not for the Polar Opening (of which Innes was ignorant at the time he drew his first map), the direction of the magnetic field anywhere in Pellucidar must be just opposite to what it is at the corresponding point on the outer surface.

This may be seen from the accompanying diagram, Fig. A. On the earth's outer surface the lines of magnetic flux may be regarded as emerging from the southern magnetic pole and running northward across the planet's surface, to converge upon the northern magnetic pole where they curve down and penetrate into the crust. The arrowheads on the magnetic field lines show the direction of magnetic flux, i.e., the

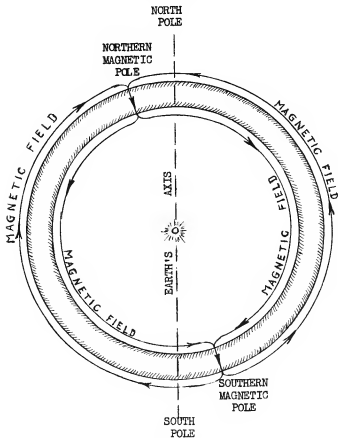


Fig. A

* If "Greenwich" is somewhere below the Cameroons, the magnetic needle would be deflected almost 10° westward of true north, as may be seen from a map of magnetic declinations for the world.

direction in which the north-seeking end of a compass needle points. The magnetic force-lines, penetrating through the shell, emerge in Pellucidar at the point directly below the northern magnetic pole, and diverging from this point run parallel to Pellucidar's surface, to converge again upon a point directly beneath the southern magnetic pole. Here they again penetrate the crust, to emerge upon the outer side at the southern magnetic pole. (Magnetic force lines always form completely closed curves.) Again the arrowheads indicate the direction in which the compass needle points. We see that whereas on the outer surface the magnetic field flows from south to north, in Pellucidar it runs from north to south; thus in the inner world the compass points in the opposite direction to that which it shows on the outer surface. It follows that what Innes marked "north" on his map is really south.

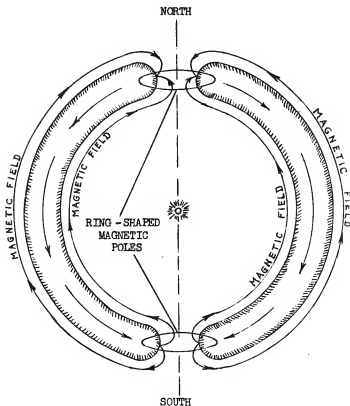


Fig. B

This situation applies if the hollow earth-shell is unbroken, i.e., if there are no openings through it near the planet's magnetic poles. However, if we assume that the ends of the planet's axis are surrounded by apertures piercing the shell, then it becomes possible for the magnetic poles to be ring-shaped around these openings, somewhat as shown in Fig. B. The earth's shell is now essentially a tubular magnet with one magnetic pole distributed around one end of the tube and the opposite pole around the other end. In such a magnet the field inside the tube has the same direction as outside, though the flux lines in the wall of the tube run in the opposite direction.

In Fig. B we note that the magnetic force lines in Pellucidar emerge from the South Polar Opening and run into the North Polar Opening; the same is true of the field lines on the outer surface. Hence a magnetic compass in Pellucidar will point in the same direction as on the outer crust, and therefore Innes — although he did not consider the physics of the situation — showed magnetic north and south correctly on his map, Fig. 1.

Note on the Atmosphere of Pellucidar

Pellucidar's atmosphere is far more opaque than that of the earth's outer surface, as shown by various passages in the books.

First, although the inner sun appears three times as large as ours (AT THE EARTH'S CORE, p. 30), the intensity of its light is apparently no greater than that of our Sun, indicating that there must be considerable absorption of radiation in Pellucidar's air-layer. It is of course possible that the Pellucidarian sun is intrinsically much less bright than ours per unit of surface area; but there is no suggestion in the books that it is any redder in color than our Sun, so it must be of similar surface temperature and therefore of comparable brilliance on its surface.

Second, as noticed by Gridley (TARZAN AT THE EARTH'S CORE, 175) the inner sun's rays do not burn the skin as does the outer crust's Sunlight, proving that most of the ultraviolet spectrum in the chemically effective region has been filtered out.

Third and most important is the fact of the remarkably limited visibility in Pellucidar. Were the inner world's air as transparent as our own, the observer should see the whole vast surface of Pellucidar arching up around and over him like a tremendous spherical map. Fine details, of course, would be indistinguishable in the more distant portions, but the great seas and land-masses, extensive cloud banks, large lakes, mountain chains and river valleys should be plainly visible, even though relief were difficult to discern. Perhaps within a few degrees of the sun, directly overhead, the great panorama would be blanked out by the glare of the central luminary. Our narrators, however, speak repeatedly of the uppouring landscape or seascape being "lost in the haze of distance" beyond thirty to fifty miles or so. In LAND OF TERROR, p. 198, Innes states that under ideal conditions of atmospheric clarity the range of vision may be about 150 miles, but in PELLUCIDAR, p. 22, when he stood on the southern shore of the Darel As at "Greenwich", he was unable to descry the northern shore, on which Amos stands, not over 10 miles distant.

One must conclude that Pellucidar's atmosphere contains some component which acts as a highly effective absorber and scatterer of light. No doubt a large part of the atmospheric haze in Pellucidar is due to water vapor near the saturation point. Although terrific rainstorms are described several times in the stories, such downpours are apparently far from frequent. Pellucidar's uniform, warm weather would cause its air to be rather heavily laden with moisture evaporated from the oceans and lakes; and because of the rarity of "cold fronts" this suspended water is relatively seldom precipitated as rain.

Most variations in Pellucidar's weather undoubtedly owe their origin to exchanges of air between the inner and outer surfaces of the earth through the Polar Openings. As the warm, moist air of the inner world passes out into our cold polar regions, the rapid decrease in temperature will of course cause its water vapor to condense into thick, opaque clouds, rain, and snow. As suggested in the text, the Polar Openings are probably filled with heavy banks of clouds so that Sunlight cannot penetrate from one side of such an aperture to the other.

In addition to the high water vapor content, it is possible that the Pellucidarian atmosphere contains a high concentration of a non-toxic "smog" consisting of organic gases released from decaying animal and vegetable matter. In a world as prolific as Pellucidar, this atmospheric component may play a significant role in the absorption and diffusion of light.

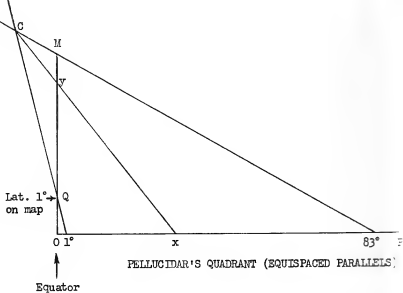


Fig. C

Appendix 3

Construction of the Latitude Scale

The principle by which the scale in Fig. 8 is constructed is illustrated in Fig. C. The horizontal line OP is of any convenient length (I used 11½ inches), and represents a semi-meridian of Pellucidar from equator (point O) to pole (P), marked off in equispaced units of latitude. The vertical line OM is this semi-meridian as it appears on the map, Fig. 6, and is equal in length to the Prime Meridian from the equator (drawn horizontally through the center of the Land of Awful Shadow) to the point which we take to be 83° N lat., the boundary of the Polar Opening (point D in Fig. 7). It is not really necessary for the lines OP and OM to be mutually perpendicular, but for certain computational purposes it is convenient to make them so.

From the 83°-mark on OP draw a straight line through M, the upper end of the vertical line. Now choose on OM a point Q such that the segment OQ shall represent the first degree of latitude on the map. 1° in Pellucidar is a trifle over 60 miles, and the radius of the Land of Awful Shadow is about 50 miles; hence we take OQ as a little more than the radius of the Shadow in Fig. 6. From the 1°-mark on OP draw a line through Q, cutting the previously drawn line through M in a point C. This point C now serves as our "center of projection" through which we project the line OP (from O to 83°) upon the line OM. Thus a point x of OP, whose actual latitude is ϕ , projects into the point y on OM when we join x to C by a straight line. The vertical distance Cy thus gives the height of the parallel of latitude ϕ on the Prime Meridian of the map (distances being measured from the equator, of course). By extending OM upward a little further, we can join the 90°-mark on OP to C and find the intersection of this line with the map meridian, a shade above M. This point would mark the position of Pellucidar's North Pole on the map if the inner world's surface were not interrupted by the Polar Opening.

Appendix 4

Note on the Pellucidarians' Homing Instinct

As remarked in the text the native Pellucidarian's homing instinct apparently is such that he can point to his natal country along the shorter arc of the

great circle joining him to it. In a footnote the question was raised whether this instinct is still operative if this great circle arc cuts across the Polar Opening. I am inclined to doubt that it does. Again, I believe a Pellucidarian might well feel lost if he were transported to the point of Pellucidar diametrically opposite his native village, for then all great circle arcs join him to his home; i.e., every direction points "home" -- an experience he would certainly find puzzling, if not confusing and disturbing. Actually, of course, in this case the shortest line joining him to his birthplace leads straight up through the central sun; but there is no suggestion in the books that the Pellucidarian ever points "home" along the chord which connects him to it, for in such event, when he is a considerable distance from home he would point not horizontally (parallel to the surface on which he is standing) but somewhat upward, the angle of elevation increasing with the distance from home. Indeed, one could then make a pretty accurate estimate of this distance by measuring or visually judging the angle of elevation of his outstretched arm. By simple plane geometry, if β is the angle between the Pellucidarian's pointing arm and the horizontal plane, then the length of the chord joining him to the spot at which he is pointing is $c = 2R \sin \beta$, where R is the radius of Pellucidar; and the length of the great circle arc joining him to that point is

$$s = r \left(\frac{\beta}{90^\circ} \right) R.$$

Thus the distance s and the angle β are directly proportional to each other; β increases by one degree for every additional 122.17 miles of distance from home. But as I say, there is no indication in the books that the Pellucidarian points along a chord; he points horizontally, tangent to a great circle arc, and is unable to make any good quantitative estimate of distance.

This mysterious inborn directional sense of the Pellucidarians is, it seems, a rather complex faculty, which may involve some specially developed sensory organs and apparently is influenced by a variety of factors, both in the individual and in his environment. Evidently it is possessed by all Pellucidarian creatures; but in TANAR, p. 91, we are told

that when a Pellucidarian is on the open sea, out of sight of land, his homing instinct fails -- yet the Korsars knew what course to sail across the great ocean to their homeland, despite their apparent lack of compasses; in LAND OF TERROR U-Val the Ruwan had no doubts about where his drifting island lay, even though it was nowhere visible and he has no fixed position; Innes used the Suvian girl Lu-Bra as a "living compass" to guide him back across the wide Bandar Az to the mainland; and Dian, following her escape from the floating island of Ko-va, found her way unerringly to Amoz across the uncharted Bandar-Lural Az. Again, in LAND OF TERROR (p. 98) Innes remarks that Zor of Zoram, once he has been at a given place, can return to it without mistake, however devious the route by which he left that place. Nevertheless, in SAVAGE PELLUCIDAR Dian, fleeing from the glade where the Manats found her and her tags, ran in a complicated path which brought her back to the same point from which she was trying to escape. In short, she got lost -- her sense of direction failed. Similarly the girl Kloeto became lost while fleeing from Suvi to Kali (LAND OF TERROR, 168).

These facts suggest that the Pellucidarian homing instinct may be a form of extrasensory (or perhaps I ought to call it "subsensory") perception which, like other faculties of that sort, varies somewhat from one person to another, and is largely dependent on the psychological and physiological conditions of the individual as well as on subliminal sensory stimuli from the external environment. Memory, emotions like fear, anxiety, depression, elation or confidence, one's particular state of physical health, and such external phenomena as the local weather are probably all involved. A landsman like Tanar might well feel less confidence in his homing instinct when he finds himself in the midst of an unknown ocean, bound for captivity in a far-off, strange land, and his subconscious anxiety then may inhibit the faculty; on the other hand Lu-Bra and Dian, although also land-dwellers sailing a broad uncharted sea, might find their homing sense unimpaired because they are escaping to freedom and live in confident expectation of returning to their homes.

The strange homing sense of the Pellucidarians is an intriguing phenomenon worthy of extensive experimental investigation.



The sole creature that remained alive within their circle was a gigantic bull mammoth. Though he put up a magnificent battle, the end was inevitable.

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TELEPHONE 56277

September 12, 1924.

Mr. M. B. Gardner,
#11 Bristol Street,
Portland, Maine.

My dear Mr. Gardner:

Your letter of May 25, addressed to the editor of the Argosy-All Story magazine has only just come to my attention.

I wish to thank you for the very nice things you said about my stories, and I quite agree with you that I should stick to highly imaginative fiction, for there are plenty of readers doing other kinds of novels much better than I can. However, I find that it rests me to take a little vacation from the highly imaginative occasionally and write some other sort of yarn, as I believe that I come back to my own particular class of fiction refreshed and with a new view point thereafter.

I hope that you will like THE BANDIT OF HELL'S BEND, now running in Argosy-All Story, which is one of my vacation stories. It ought to be reasonably logical, or as nearly so as my style of fiction ordinarily is, since I soldiered in Arizona in the 7th Cavalry a great many years ago, and was a cow puncher in Idaho before that. However, styles change in cow punchers as in other things, and the puncher of the movies is not at all the sort of person I knew in Idaho and Arizona thirty years ago.

Again thanking you, and with kindest regards, I
am

Very sincerely yours,





Kenneth Smith
30 MAY 1969